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PRESSURIZED OVAL CYLINDERS

WITH CLOSELY SPACED RINGS

by

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POLYTECHNIC INSTITUTE OF BROOKLYN

DEPARTMENT
of
AEROSPACE ENGINEERING
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SUMMARY

An analysis is presented for the classical, linear, elastic behavior of a ring-reinforced oval cylinder subjected to a uniform hydrostatic pressure. Use is made of the theorem of the minimum of the total potential energy as well as an appropriate combination of the results of two previously published analyses. One of these deals with oval cylindrical shells alone, whereas the second deals with isolated oval rings. The combined analysis presented herein is employed to obtain numerical results for a limited parametric study which covers major-to-minor axis ratios in the range from 1.0 (circular cylinders) to 1.5. In addition to the anticipated result that the severity of the stresses and deformations generally increases as the major-to-minor axis ratio increases, it is shown that a change from inside rings to outside rings, or vice versa, (all other parameters being held constant) generally results in radical changes in the stress distribution throughout the entire oval cylinder.

SYMBOLS

A	= uniform cross-sectional area of oval reinforcing ring, including contacted region of shell
A^*	= enclosed frontal area of oval shell cross section
$\bar{A}_n^{(j)}$, $\bar{B}_n^{(j)}$, $\bar{C}_n^{(j)}$	= complex constants in complementary function of oval shell solution
a_{ik}	= elements in matrix solution for oval reinforcing ring
a, b	= minor and major axes, respectively, of oval cross section
B	= width of ring acted upon by q_o
$C_o^{(j)}$	= arbitrary complex constants of integration appearing in shell solution
E	= Young's modulus
$F_i^{(j)}$	= complex constants defined by Eq. (26)
h	= uniform shell wall thickness
I	= uniform moment of inertia of A with respect to a transverse centroidal axis, see Eq. (7)
i, j, k, n	= integers
L	= unsupported axial length of a typical bay of oval ring-reinforced cylinder (Fig. 1)
L_o	= perimeter of median line of oval cross section
M, M_c	= bending moment in ring with respect to reference line and centroidal line, respectively
N	= circumferential force in ring
p	= parameter defined by Eq. (12)
q_o	= uniform external hydrostatic pressure
R_k	= elements of load matrix on ring defined by Eq. (23)
r_o	= $L_o/2\pi$

r, r_c	= local radius of curvature of median surface of oval shell cross section and of ring centroidal line, respectively
S, Z	= circumferential and radial interaction loads, respectively (Fig. 2)
S_n, Z_n	= harmonic components of S and Z, respectively
u, v, w	= axial, circumferential and inward radial displacement components of a point on the median surface of the oval shell, respectively
u_n v_n, w_n	= harmonic components of u, v and w, respectively
u_{nc}, v_{nc}, w_{nc}	= complementary functions for u_n, v_n and w_n, respectively
u_{np}, v_{np}, w_{np}	= particular integrals for u_n, v_n and w_n, respectively
V, W	= circumferential and radial displacement components of a point on the reference line of the oval ring, respectively
V_n. W_n	= harmonic components of V and W, respectively
X_i	= ring displacement matrix defined by Eq. (21)
x, s, z	= axial, circumferential and inward radial coordinate, respectively, with origin at midbay of shell median surface
z_1	= z coordinate of surface in ring upon which q_o acts
z_c	= radial coordinate measured from centroidal line in the ring
$\bar{z}$	= z coordinate of centroidal line of ring
ϵ, $\varkappa$	= strain and change of curvature, respectively, for a point on the ring reference line
Λ_j	= complex roots which appear in complementary function for shell
ν	= Poisson's ratio
ξ	= noncircularity parameter which fixes b/a

σ_x, σ_s, τ_{xs}	= axial, circumferential and in-plane shear stresses in shell
σ_{xb}, σ_{sb}, τ_{xsb}	= bending components of σ_x, σ_s and τ_{xs}, respectively
σ_{xm}, σ_{sm}, τ_{xsm}	= membrane components of σ_x, σ_s and τ_{xs}, respectively
σ	= circumferential stress in ring
$(\ )'$	= $d(\ )/ds$
$(\ )_{,x}$	= $\partial(\ )/\partial x$
$(\ )_{,s}$	= $\partial(\ )/\partial s$

INTRODUCTION

Ring-reinforced circular cylindrical shells subjected to either an internal or external pressure have found wide application in structures designed for either flight, land-based, or undersea operation. The elastic behavior of such structures, even including the so-called "beam-column effect", is well understood and has been widely reported upon in the literature; see, for example, Ref. 1. At times the designer is confronted with the problem of having to analyze ring-reinforced cylinders of oval cross section. Such shapes are sometimes deliberately introduced to satisfy space confinements or other design requirements, but often they are the result of measurable imperfections in supposedly circular cylinders. In order to gain insight into the relatively unexplored behavior of ring-reinforced cylinders deliberately designed with oval cross sections the David Taylor Model Basin has conducted and published the results of initial tests on such a cylinder (Ref. 2).

This report presents a theoretical analysis of the classical, linear, elastic behavior, under a uniform hydrostatic pressure, of a typical bay (located at some distance from the ends) in an oval cylindrical shell which is reinforced by many oval rings equally spaced along the cylinder axis; see Figs. 1 and 2. The rings are assumed to be closely spaced so that there results a large number of short bays having lengths which are less than the average radius. Each ring is taken to include the contacted region of shell.

The analysis is based upon the principle of the minimum of the total potential energy and incorporates the theoretical work of Refs. 3 and 4, the major results of which are applicable to short oval shells under arbitrary edge loads, and to arbitrarily loaded oval reinforcing rings, respectively. In fact, the analysis of Ref. 3 has been applied to simply supported short oval shells under a uniform lateral load (Ref. 5) and has been shown to result in good agreement with a more exact double Fourier series solution, Ref. 6. In a preliminary application (Ref. 7, in which results are presented without the accompanying theory), the present analysis has shown remarkable agreement with the DTMB data of Ref. 2. Subsequently, at the request of the Office of Naval Research, results were obtained for two more ring-reinforced oval cylinders and reported upon in Ref. 8, again without the accompanying theory.

In addition to giving a detailed description of the connecting conditions and approach used in applying the analyses of Refs. 3 and 4, there are presented below the numerical results of a limited parametric study. This study involves variations in the major-to-minor axis ratio b/a, the cross-sectional properties of the reinforcing rings, and the location of the rings, e.g., inside rings or outside rings. Extensive tables and graphs in the range $1.0 \leq b/a \leq 1.5$ are presented. In addition to the anticipated result that the severity of the stresses and deformations generally increases as b/a is increased it is shown that a change in ring location alone, e.g., a change from inside rings to outside rings, generally results in radical changes in the stress distribution throughout the entire oval cylinder.

GOVERNING EQUATIONS

Following Ref. 3, it is here assumed that the stress-displacement relationships for any point in the wall of a short oval cylindrical shell are adequately described by equations which correspond in accuracy to those of Donnell, with the nonlinear (buckling) terms omitted. On the other hand, if the effect of inside or outside reinforcing rings is to be carefully evaluated and if deep-ring effects are to be included, then, following Ref. 4, the stress-displacement relationships for the ring must be of the more accurate Flügge type. The above considerations imply that

$$\sigma_x = [E/(1-\nu^2)][u_{,x} + \nu(v_{,s} - w/r) - z(w_{,xx} + \nu w_{,ss})] \tag{1a}$$

$$\sigma_s = [E/(1-\nu^2)][v_{,s} - w/r + \nu u_{,x} - z(w_{,ss} + \nu w_{,xx})] \tag{1b}$$

$$\tau_{xs} = [E/2(1 + \nu)](u_{,s} + v_{,x} - 2zw_{,xs}) \tag{1c}$$

$$\sigma = E\{\epsilon - [rz/(r - z)]\varkappa\} \tag{1d}$$

where

$$\epsilon = V' - W/r \tag{2a}$$

$$\varkappa = W'' + W/r^2 + V(1/r)' \tag{2b}$$

In the above equations x, s and z are the axial, circumferential and inward radial coordinates, respectively, of any point in the oval shell wall (see Fig. 1). The median line of the oval cross section is assumed to have a local radius of curvature given by $r = r(s)$. The axial, circumferential and in-plane shear stresses in the shell wall are denoted by σ_x, σ_s and τ_{xs}, respectively, whereas the circumferential stress in the ring is denoted by σ. The quantities u, v and w repr ent the displacements of any point in the median surface ($z = 0$) of the shell wall in the coordinate directions x, s and z, respectively, and commas represent partial differentiation of any quantity which is a function of both x and s with respect to the variables which they preceed. On the other hand, V and W represent the circumferential and radial displacements, respectively, of any point of the ring which lies on the circumferential line of contact between the ring and the median surface of the shell, and primes represent total differentiation with respect to s of any quantity which is a function of that variable only. The line of contact between ring and shell ($x = \pm L/2$, $z = 0$), herein called the reference line, does not generally coincide with the centroid of the ring cross section; see Fig. 2. The quantities ϵ and κ are the strain and change of curvature of any point on the reference line. Finally, E and ν represent Young's modulus (assumed identical for both ring and shell) and Poisson's ratio, respectively.

For a typical bay of unsupported length L (see Fig. 1), the appropriate boundary and connecting conditions between ring and shell are

$$u_{,s}(\pm L/2,s) = w_{,x}(\pm L/2,s) = 0 \qquad (3a,b)$$

$$v(\pm L/2,s) = V(s) \qquad w(\pm L/2,s) = W(s) \qquad (3c,d)$$

$$\int_0^{L_o} \int_{-h/2}^{h/2} \sigma_x(\pm L/2,s,z)\,dz\,ds = -q_o A^* \qquad (3e)$$

where L_o and A^* are, respectively, the perimeter and the enclosed frontal area of the oval cross section, and h is the shell wall thickness. The above conditions permit no out-of-plane warping or twisting of the rings, assure identical deformations of both ring and shell at their line of contact, and equate the total end load (which is due to the uniform external hydrostatic pressure q_o) to the resultant axial stress in the shell at the ends $x = \pm L/2$. In addition, it is assumed that at $z = z_1$, the ring has a surface of width B exposed to the uniform pressure q_o (see Fig. 2). An application of the well-known theorem of the minimum of the total potential energy results in

$$\begin{aligned}
&[Eh/(1-\nu^2)]\int_0^{L_o}\int_{-L/2}^{L/2}\{[u_{,xx} + (1/2)(1-\nu)u_{,ss} + (1/2)(1+\nu)v_{,xs} - (\nu/r)w_{,x}]\delta u \\
&+ [v_{,ss} + (1/2)(1-\nu)v_{,xx} + (1/2)(1+\nu)u_{,xs} - (w/r)_{,s}]\delta v \\
&- [(h^2/12)\nabla^4 w + (1/r)(v_{,s} - w/r + \nu u_{,x}) - q_o(1-\nu^2)/Eh]\delta w\}dxds \\
&+ \int_0^{L_o}\{[N' - M'/r + S]\delta V + [M'' + N/r + q_o B(1-z_1/r) + Z]\delta w\}ds = 0
\end{aligned} \qquad (4)$$

where N and M, respectively, are the circumferential force and bending moment in the ring referred to the reference line (see Fig. 2), whereas S and Z, respectively, represent the circumferential and axial interaction loads which act upon the ring. Because each ring interacts with a portion of shell to its left and another portion to its right, the quantities $\mp$ S and $\mp$Z are twice the effective running shear and transverse shear, respectively, in the shell at the ends $x = \pm L/2$.

The quantities N, M, S and Z are related to the displacements by the expressions

$$N = \int_A \sigma dA = EA\{\epsilon - (r^2/r_c)[\bar{z}/r + I/Ar_c{}^2]\kappa\} \tag{5a}$$

$$M = \int_A \sigma z dA = EAr\{(\bar{z}/r)\epsilon - (r^2/r_c)[(\bar{z}/r)^2 + I/Ar_c{}^2]\kappa\} \tag{5b}$$

$$S(s) = \mp [Eh/(1 + \nu)]v_{,x}(\pm L/2, s) \tag{5c}$$

$$Z(s) = \pm [Eh^3/6(1 - \nu^2)]w_{,xxx}(\pm L/2, s) \tag{5d}$$

where A is the uniform cross-sectional area of the oval reinforcing rings (including the contacted region of shell) and r_c is the local radius of curvature of the centroidal line of the ring, which is located at the constant distance $\bar{z}$ from the reference line. Thus, if z_c is the distance from the centroidal line to any point in the ring located at the distance z from the reference line (see Fig. 2) the following equalities hold

$$\bar{z} = z - z_c - r - r_c = (1/A) \int_A z dA \qquad (6)$$

The quantity I is given by

$$I = \int_A [z_c^2/(1 - z_c/r_c)] dA \approx \int_A z_c^2 dA \qquad (7)$$

i.e., I is approximately equal to the uniform centroidal cross-sectional moment of inertia of the reinforcing ring. In Ref. 4 it is shown that this approximation (made in what follows) is valid provided the depth-to-radius ratio of the rings does not exceed approximately 1/5, the usual case in ring-reinforced cylinders.

In Eq. (4) δu, δv, δw, δV and δW represent arbitrary variations of the corresponding displacement quantities. The coefficients of δu, δv and δw (which, when equated to zero, yield the partial differential equations of equilibrium of a shell element) are identical to those which appear in the energy expression of Ref 3. Similarly, the coefficients of δV and δW (which, when equated to zero yield the ordinary differential equations of equilibrium of a ring element) are identical to those which appear in the energy expression of Ref. 4. In order to obtain energy solutions which are applicable to hydrostatically loaded ring-reinforced oval cylinders use will be made of the energy solutions of both Refs. 3 and 4. The solution of Ref. 3 is applicable to uniformly loaded short oval cylindrical shells subjected to arbitrary edge conditions. On the other hand, the solution of Ref. 4 applies to isolated oval rings subjected to arbitrary distributed circumferential and radial loads. Both solutions assume truncated circumferential Fourier series for the displacements.

ENERGY SOLUTION

In obtaining an energy solution to the problem posed it is assumed, following Refs. 3 to 8, that the local curvature $1/r$ of the median line of the oval cross section is given by

$$1/r = (1/r_o)[1 + \xi \cos (4\pi s/L_o)] \tag{8}$$

where $r_o = L_o/2\pi$ is the mean radius and ξ is a noncircularity parameter which lies in the range $0 \leq \xi \leq 1.0$. Negative values of ξ need not be considered because they merely correspond to an interchange of the major and minor axes. The values $\xi > 1$ are not permitted because they correspond to cross sections which are not convex at every point. A complete study of the geometry of oval sections defined by Eq. (8), which are symmetric with respect to both the major and minor axes (see Fig. 1), is given in Ref. 6, where it is shown that the enclosed area A^* and the major-to-minor axis ratio b/a of the oval are given by

$$A^*/\pi r_o^2 = 1 - \xi^2/6 + \xi^4/240 + \cdots \tag{9}$$

$$\frac{b}{a} = \frac{1 + \xi/3 - \xi^2/15 - \xi^3/105 + \xi^4/945 + \cdots}{1 - \xi/3 - \xi^2/15 + \xi^3/105 + \xi^4/945 + \cdots} \tag{10}$$

On the other hand, if b/a is known then ξ can be obtained from the formula

$$\xi = 3p - (36/35)p^3 + \cdots \tag{11}$$

where

$$p = (b/a - 1)/(b/a + 1) \tag{12}$$

In Ref. 6 it is shown that if ξ is varied from 0 to 1 then b/a varies from 1.00 to 2.06 and the parameter p changes from 0 to 0.347. A fairly broad class of elliptical cross sections can be approximated by Eq. (8) (see Ref. 6). Also, in Ref. 7 it is shown that results in good agreement with experiment are obtained by fitting this equation to a doubly symmetric oval constructed from pairs of circular arcs.

It is further assumed, as in Refs. 3, 4, 5, 7 and 8 that the displacements of both the shell and ring are adequately represented by the following truncated circumferential Fourier series.

$$u(x,s) = (1/2)u_o(x) + \sum_{n=4,8.} u_n(x) \cos (n\pi s/L_o) \tag{13a}$$

$$v(x,s) = \sum_{n=4,8.} v_n(x) \sin (n\pi s/L_o) \tag{13b}$$

$$w(x,s) = (1/2)w_o(x) + \sum_{n=4,8.} w_n(x) \cos (n\pi s/L_o) \tag{13c}$$

$$V(s) = \sum_{n=4,8.} V_n \sin (n\pi s/L_o) \tag{13d}$$

$$W(s) = (1/2)W_o + \sum_{n=4,8.} W_n \cos (n\pi s/L_o) \tag{13e}$$

Under the above assumptions the interaction loads, Eqs. (5c) and (5d), take the form

$$S(s) = \sum_{n=4,8.} S_n \sin (n\pi s/L_o) \qquad (14a)$$

$$Z(s) = (1/2)Z_o + \sum_{n=4,8.} Z_n \cos (n\pi s/L_o) \qquad (14b)$$

where

$$S_n = \mp [Eh/(1 + \nu)]dv_n(\pm L/2)/dx \qquad n = 4, 8. \qquad (15a)$$

$$Z_n = \pm [Eh^3/6(1 - \nu^2)]d^3w_n(\pm L/2)/dx^3 \qquad n = 0, 4, 8. \qquad (15b)$$

When the above assumptions are used in Eq. (4), there result eight coupled ordinary differential equations for the determination of the eight shell parameters u_o, u_4, u_8, v_4, v_8, w_o, w_4, w_8, which are all functions of x, and five coupled linear algebraic equations for the determination of the five ring parameters V_4, V_8, W_o, W_4, W_8, which are constants. The boundary conditions (corresponding to Eqs. 3) for the determination of the above parameters are

$$u_n(\pm L/2) = 0 \qquad n = 4, 8. \qquad (16a)$$

$$dw_n(\pm L/2)/dx = 0 \qquad n = 0, 4, 8. \qquad (16b)$$

$$v_n(\pm L/2) = V_n \qquad n = 4,\ 8. \tag{16c}$$

$$w_n(\pm L/2) = W_n \qquad n = 0,\ 4,\ 8. \tag{16d}$$

$$du_o(\pm L/2)/dx = (\nu/r_o)(W_o + \xi W_4) - q_o r_o[(1-\nu^2)/Eh](A^*/\pi r_o^2) \tag{16e}$$

The shell displacement parameters are expressible in the form

$$u_n(x) = u_{np}(x) + u_{nc}(x) \tag{17}$$

with similar expressions for v_n and w_n. The quantities u_{np}, v_{np} and w_{np} are particular integrals. Formulas for these quantities, applicable to the present case of an applied uniform external hydrostatic pressure q_o, are presented in Ref. 3 where it is shown that du_{np}/dx, v_{np} and w_{np} are constants. Also, it is shown that u_{nc}, v_{nc} and w_{nc}, the complementary functions, are of the form

$$(Eu_{nc}/q_o h) = \text{Re} \sum_{j=0,4}^{16} C_o^{(j)} \bar{A}_n^{(j)} \sinh(2x\Lambda_j/L) \qquad n = 0,\ 4,\ 8. \tag{18a}$$

$$(Ev_{nc}/q_o h) = \text{Re} \sum_{j=0,4}^{16} C_o^{(j)} \bar{B}_n^{(j)} \cosh(2x\Lambda_j/L) \qquad n = 4,\ 8. \tag{18b}$$

$$(Ew_{nc}/q_o h) = \text{Re} \sum_{j=0,4}^{16} C_o^{(j)} \bar{C}_n^{(j)} \cosh(2x\Lambda_j/L) \qquad n = 0,\ 4,\ 8. \tag{18c}$$

where Re denotes the real part of the complex quantity which it preceeds and $\bar{A}_n^{(j)}$, $\bar{B}_n^{(j)}$ and $\bar{C}_n^{(j)}$ are known complex constants which depend upon five distinct complex roots Λ_j (see Ref. 3). These roots, which are arbitrarily selected so that both the real and imaginary parts are positive, are the distinct roots of a twentieth degree algebraic equation presented in Ref. 3. The other fifteen (unessential) roots are the negative, the conjugate and the negative conjugate of the five distinct roots Λ_j. The five complex constants $C_o^{(j)}$, i.e., the ten constants which are composed of the real and imaginary parts of the five $C_o^{(j)}$, are the arbitrary constants of integration which must be determined in each instance by satisfying boundary conditions. In Ref. 3 the constants were determined to satisfy the conditions of a clamped shell and in Ref. 5 they were determined to satisfy simple supports at the shell edges. Here the constants $C_o^{(j)}$ are to be determined so as to satisfy Eqs. (16) applicable to ring-reinforced edges. We note here that the expression for $du_o(x)/dx$ is particularly simple in form and is given by

$$du_o(x)/dx = (\nu/r_o)[w_o(x) + \xi w_4(x)] - [q_o r_o(1-\nu^2)/Eh](A^*/\pi r_o^2) \qquad (19)$$

showing that the condition Eq. (16e) is automatically satisfied for all x and not only at the ends $x = \pm L/2$ (see Ref. 3).

In Ref. 4 it is shown how, for given loads S_n and Z_n, the ring displacement parameters V_n and W_n can be expressed in the form

$$X_i = \sum_{k=1,2}^{6} a_{ik} R_k \qquad i = 1,2,3,4,5. \qquad (20)$$

where X_i is the ring displacement column matrix given by

$$X_i = \{W_o, W_4, W_8, V_4, V_8\} \tag{21}$$

$$\text{i.e.,} \qquad X_i = \begin{cases} W_n & n = 0,4,8. \qquad \text{if } i = n/4 + 1 \\ V_n & n = 4,8. \qquad \text{if } i = n/4 + 3 \end{cases} \tag{22}$$

and R_k is the generalized load column matrix given by

$$R_k = (r_o{}^2/EA)\{q_oB,\ Z_o/2,\ Z_4,\ Z_8,\ S_4,\ S_8\} \tag{23}$$

The constants a_{ik} are the elements of a five-by-six matrix (see Ref. 4).

The unknown interaction loads S_n and Z_n can be eliminated from the ring solution Eq. (20) in favor of the unknown constants $C_o^{(j)}$ by substituting the shell solutions Eqs. (17) and (18) into Eqs. (15). The result of this procedure (since v_{np} and w_{np} are constants) is

$$(S_n/q_oh) = -[2/(1+\nu)](h/L)\mathrm{Re}\sum_{j=0,4}^{16} C_o^{(j)}\bar{B}_n^{(j)}\Lambda_j \sinh \Lambda_j \qquad n=4,8. \tag{24a}$$

$$(Z_n/q_oh) = [4/3(1-\nu^2)](h/L)^3\mathrm{Re}\sum_{j=0,4}^{16} C_o^{(j)}\bar{C}_n^{(j)}\Lambda_j^3 \sinh \Lambda_j \qquad n=0,4,8. \tag{24b}$$

Substituting Eqs. (24) into Eq. (20) results in

$$(EX_i/q_oh) = (r_o/h)^2(Lh/A)[a_{i1}(B/L) + \mathrm{Re}\sum_{j=0,4}^{16} C_o^{(j)}F_i^{(j)}] \qquad i = 1,2,3,4,5. \tag{25}$$

where

$$F_i^{(j)} = [4/3(1-\nu^2)](h/L)^2\{(h/L)^2[a_{i2}/2 + a_{i3}\bar{C}_4^{(j)} + a_{i4}\bar{C}_8^{(j)}]\Lambda_j^2$$

$$- [3(1-\nu)/2][a_{i5}\bar{B}_4^{(j)} + a_{i6}\bar{B}_8^{(j)}]\}\Lambda_j \sinh \Lambda_j \tag{26}$$

The real and imaginary parts of the five complex constants $C_o^{(j)}$ are now determined by simultaneously solving the following ten linear algebraic equations, which are obtained by substituting the shell and ring solutions Eqs. (17), (18), (21) and (25) into the ten boundary conditions Eqs. (16a) to (16d).

$$\mathrm{Re} \sum_{j=0,4}^{16} C_o^{(j)}\bar{A}_n^{(j)} \sinh \Lambda_j = 0 \qquad n = 4,\ 8. \tag{27a}$$

$$\mathrm{Re} \sum_{j=0,4}^{16} C_o^{(j)}\bar{C}_n^{(j)}\Lambda_j \sinh \Lambda_j = 0 \qquad n = 0,\ 4,\ 8. \tag{27b}$$

$$\mathrm{Re} \sum_{j=0,4}^{16} C_o^{(j)}[\bar{B}_n^{(j)} \cosh \Lambda_j - (r_o/h)^2(Lh/A)F_i^{(j)}]$$

$$= (r_o/h)^2(Lh/A)(B/L)a_{i1} - (Ev_{np}/q_oh) \qquad n = 4,\ 8. \quad i = (n/4) + 3 \tag{27c}$$

$$\mathrm{Re} \sum_{j=0,4}^{16} C_o^{(j)}[\bar{C}_n^{(j)} \cosh \Lambda_j - (r_o/h)^2(Lh/A)F_i^{(j)}]$$

$$= (r_o/h)^2(Lh/A)(B/L)a_{i1} - (Ew_{np}/q_oh) \qquad n = 0,\ 4,\ 8. \quad i = (n/4) + 1 \tag{27d}$$

Once the above equations are solved for the ten unknowns (real and imaginary parts of $C_o^{(j)}$) the interaction loads can be obtained from Eqs. (14) and (24). Similarly, the shell displacements are given by Eqs. (13a) to (13d), (17) and (18), whereas those for the ring are obtained from Eqs. (13d), (13e), and (20).

Having determined the displacements in both the ring and shell, it is possible to obtain all the stresses from Eqs. (1). It is convenient to separate each shell stress into two parts, a membrane component and a bending component. Thus, for example, the total axial stress at the inside or outside surface, $z = \pm h/2$, is assumed to be given by

$$\sigma_x(x,s, \pm h/2) = \sigma_{xm}(x,s) \pm \sigma_{xb}(x,s) \tag{28}$$

where σ_{xm} and σ_{xb}, the axial membrane and bending components, respectively, are defined as

$$\sigma_{xm}(x,s) = \sigma_x(x,s,0) \tag{29a}$$

$$\sigma_{xb}(x,s) = (1/2)[\sigma_x(x,s,h/2) - \sigma_x(x,s,-h/2)] \tag{29b}$$

The stresses σ_s and τ_{xs} are also separated into membrane and bending components by relationships similar to those presented in Eqs. (28) and (29) for σ_x. Similarly, by means of Eqs. (1d), (5a), and (5b), the ring stress can be written in the form

$$\sigma = N/A + (M_c r_c/I)[z_c/(r_c - z_c) - I/Ar_c^2] \approx N/A + M_c z_c/I \quad (30)$$

where $M_c = M - \bar{z}N$ is the circumferential bending moment referred to the centroidal axis in the ring cross section. The well-known approximation in Eq. (30) is, as discussed in Ref. 4, generally valid for reinforcing rings of engineering interest. Also, as discussed in Ref. 4, in obtaining final numerical results for N and M_c it is best to suppress the spurious higher harmonics which are introduced when the strain and change of curvature ϵ and κ are multiplied by terms like $1/r$ or $1/r_c$, and to retain only as many harmonics as are assumed for the original series for the ring displacements. In the numerical results which follow, the spurious harmonics of the order of cos $(12\pi s/L_o)$ and higher have been suppressed in N and M_c.

NUMERICAL RESULTS

The preceeding theory has been used to obtain a complete set of numerical results for a limited parameter range of short oval ring-shell combinations. For each configuration considered it was assumed that $L_o/L = 24$ $(r_o/L = 3.820)$, $L_o/h = 576$ $(r_o/h = 91.67)$ and $\nu = 0.3$. The effect of any pressure load q_o acting at the location z_1 on an exposed width B of the ring has been neglected by setting B = 0. The uniform cross-sectional area and moment of inertia of the oval reinforcing rings was varied to arrive at Cases 1 to 4 of Table 1. Cases 1 and 2 have identical ring areas (for a fixed shell wall thickness) which are smaller than the areas (also identical) for Cases 3 and 4, whereas the moment of inertia increases monotonically from Case 1 to Case 4. On the other hand, Cases 1 and 3 have identical radii of gyration which are smaller than the radii of gyration (also identical) for Cases 2 and 4. The parameter $\bar{z}/h$, listed in Table 1, characterizes the location of the ring; i.e., $\bar{z}/h > 0$ for inside rings, $\bar{z}/h < 0$ for outside rings and $\bar{z}/h = 0$ for median line rings (a case of theoretical interest in which the centroid of the ring cross section is assumed to coincide with the median line in the shell wall).

Obviously, the data in Table 1 specifies only the gross geometrical properties of a ring cross section and not the actual shape, i.e., channel sections, T-sections, I-sections, etc., nor is it necessary for purposes of analysis to specify such details. However, an estimate of the physical size of the rings implied by Cases 1 through 4 can be obtained by assuming that T-sections of web depth d, flange width b, and uniform thickness t are employed as reinforcing rings by welding the foot of the web to the shell. Then, for Cases 1 and 3, $d/h \approx 8.1$ and $b/h \approx 7.4$, whereas, for Cases 2 and 4, $d/h \approx 9.9$ and $b/h \approx 10.6$; also, $t/h \approx 0.44$, 0.33, 0.77, 0.59 for Cases 1 through 4, respectively. In general, Case 1 represents the lightest and most flexible ring, whereas Case 4 represents the heaviest and stiffest ring.

Complete numerical results were obtained for five major-to-minor axis ratios $b/a = 1.1$, 1.2, 1.3, 1.4, 1.5. Thus, for example, the rings corresponding to Cases 1 to 4 of Table 1 were considered as inside rings for each of the five values of b/a, giving a total of twenty combinations of inside rings. The same rings were also used as outside rings (twenty cases) and median line rings (twenty cases), resulting in a total study of sixty cases of ring-reinforced oval cylinders. In addition, the results for clamped oval cylinders (infinitely stiff rings) are also included for each of the five values of b/a. The numerical study was completed by obtaining all the corresponding results for b/a = 1.0 (circular cylinders).

For both inside and outside rings having cross sections defined by Cases 1 to 4 of Table 1 (page T1) there are presented in Tables A1 to A8 (pages T2 to T5), respectively, the nondimensional axial membrane stresses, axial bending stresses, circumferential membrane stresses, circumferential bending stresses, shear membrane stresses, shear bending stresses, radial deformations, and circumferential deformations, for b/a = 1.1. Corresponding results for b/a = 1.2, 1.3, 1.4, 1.5, respectively, appear in Tables A9 to A16 (pages T6 to T9), Tables A17 to A24 (pages T10 to T13), Tables A25 to A32 (pages T14 to T17), and Tables A33 to A40 (pages T18 to T21). The results for inside rings are presented in the upper half of each table; those for outside rings appear in the lower half of the same table. These data are tabulated at locations which are the intersections of shell generators located at $4s/L_o = 0$ (end of major axis), 0.25, 0.50, 0.75, 1.0 (end of minor axis) with cross sections at $2x/L = 0$ (mid-bay), 0.2, 0.4, 0.6, 0.8, 1.0 (ring). Similar results for median-line ring cases appear in Tables B1 to B20 (pages T22 to T31).

Tables C1 and C2 (page T32) relate to ring-reinforced circular cylinders, results for which are available in the literature. For example, they can be obtained from Ref. 1 by neglecting "beam-column" effects. Naturally, in these cases there is no variation circumferentially and the in-plane shear stresses are identically zero. Also, the axial membrane stress

$\sigma_{xm}/q_o = - r_o/2h = -45.8$ everywhere. In the case of circular cylinders all results are independent of the ring cross-sectional moment of inertia. Consequently, for median line rings, Cases 1 and 2 are identical, as are Cases 3 and 4. For both inside and outside rings the small difference between Cases 1 and 2 or between Cases 3 and 4 is due to the fact that Cases 1 and 2, as well as Cases 3 and 4, have differing values of $\bar{z}/h$ and, hence, slightly different radii.

Tables D1 to D6 (pages T33 to T35) refer to the reinforcing rings and present the radial and circumferential interaction loads as well as the circumferential force and bending moment distributions for all cases, i.e., inside, outside and median line rings for b/a = 1.0 (circular cylinders), 1.1, 1.2, 1.3, 1.4, 1.5.

Tables E1 to E7 (pages T36 to T38) refer to clamped cylinders (infinitely stiff reinforcing rings). The results in Tables E1, E3, and E5 for b/a = 1.1, 1.3, 1.5, respectively, have been obtained from the work of Ref. 3, where it was also shown that the concept of an equivalent circular cylinder solution (in which the shell cross sections at a ring are forced to remain plane) is an excellent approximation to the energy solution. The results shown in Tables E2 and E4 for b/a = 1.2 and 1.4, respectively, have been obtained on the basis of such an equivalent circular cylinder solution. This approximate solution results in zero values for the in-plane shear stresses and circumferential displacements and, consequently, these negligible quantities do not appear in Tables E2 or E4. Table E6 presents stresses and deformations for clamped circular cylinders, whereas Table E7 shows the interaction loads which act upon the clamped edge, i.e., upon an infinitely stiff reinforcing ring.

Figures 3 to 35 present curves in the range 1.0 (circular case) $\leq b/a \leq 1.5$ of all the dominant quantities for all cases at each of four points, i.e., at mid-bay at the end of the major axis ($x = s = 0$), at mid-bay at the end of the minor axis ($x = 0$, $s = L_o/4$), at ring at the end of the major axis ($x = L/2$, $s = 0$), and at ring at the end of the minor axis ($x = L/2$, $s = L_o/4$). Figures 3 to 13, which refer only to inside ring cases, present the membrane and bending components of the axial and circumferential stresses, the radial deformations, and the circumferential force and bending moment in the reinforcing ring. The curves labeled 1, 2, 3, 4 refer to the corresponding cases of different rings listed in Table 1, whereas the label C on a curve refers to clamped cylinders. Corresponding results for outside ring cases appear in Figs. 14 to 24, whereas those for median-line rings are in Figs. 25 to 35.

DISCUSSION

A survey of the numerical results presented in the tables on pages T2 to T38 and in the graphs of Figs. 3 to 35 indicates that, for all cases of inside and outside rings defined in Table 1, the total axial and circumferential stresses are most severe at the ring at the end of the major axis, i.e., at $x = L/2$, $s = 0$. Of course, due to symmetry, the shear stresses and circumferential displacements vanish along the generators at the ends of the major and minor axes. At the most severely stressed point axial stresses, circumferential stresses, radial deformations, and circumferential forces and bending moments in the reinforcing rings, respectively, are plotted as functions of b/a in Figs. 5, 9, 11 and 12 for inside ring cases. Corresponding results for outside ring cases appear in Figs. 16, 20, 22 and 23, whereas, those for median-line ring cases are displayed in Figs. 27, 31, 33 and 34.

Inspection of the figures mentioned above indicates that, as one would expect, the severity of the stresses usually increases as b/a is increased. Also, it is immediately apparent that the curves labeled C, which refer to clamped cylinders, are in most instances radically different from the family of curves labeled 1, 2, 3, 4, which refer to the corresponding cases listed in Table 1. Thus, in general, one can not obtain reasonable approximations for cylinders reinforced by what would be considered rather heavy rings in an actual design (Case 4, for example) by assuming that these rings are infinitely rigid. This radical departure of the results for clamped cylinders from those for ring-reinforced cylinders is generally exhibited throughout the structure and not only at the points for which graphs are presented.

Another feature exhibited in the graphs is the significant effect that the inside, outside, or median line location of the reinforcing ring has on the stress distribtuion throughout an oval cylinder. For circular cylinders (b/a = 1.0) the ring location produces only a secondary effect. However, as b/a is increased it can be seen by a comparison of Figs. 5 and 16 that the sign of the axial bending stress changes from negative to positive (without a significant change in absolute value) in going from inside rings to outside rings, whereas, for median line rings (Fig. 27) the magnitude of the axial bending stress is only about 40% of that obtained for inside or outside rings. Similar sign reversals in the axial bending stresses occur throughout the oval cylinders considered in going from inside to outside reinforcing rings.

A comparison of Figs. 9, 20 and 31 shows that, for the larger values of b/a, the sign of the circumferential membrane stress changes from positive to negative (without a significant change in absolute value) in going from inside rings to outside rings, whereas, for median-line rings the magnitude of these stresses are greatly reduced. For circular cylinders the circumferential membrane stresses are always compressive. However, for the inside and median-line rings considered, these stresses vary monotonically from compressive to tensile as b/a is increased (see Figs. 9 and 31). When going from inside to outside reinforcing rings radical changes generally occur in the behavior of the circumferential membrane stress for the oval cylinders considered.

As regards the radial deformations shown in Figs. 11, 22 and 33 for inside, outside, and median-line rings, respectively, it is seen that the displacements at the ring are substantially the same as those at mid-bay, the difference between the two displacements being of the same order of magnitude in ring-reinforced cylinders as in clamped cylinders. Generally, the outward displacement at the ends of the major axis is approximately 50% greater than the inward displacement at the ends of the minor axis. The maximum radial deformations for inside rings are approximately the same as those for outside rings; however, these displacements are increased four to five fold in the case of median line rings. For circular cylinders the radial deformations do not involve any substantial circumferential bending; i.e., the deformations are predominantly of a pure extensional nature (circumferentially). On the other hand, for oval cylinders the radial deformations involve a great deal of circumferential bending. This behavior indicates the probability that these deformations are controlled by the moment of inertia of the rings together with an effective width of shell. Naturally, the effective moment of inertia of such a combination of ring and shell would be about the same for inside or outside rings and in each instance greater than for median line rings. If the full bay length of shell is combined with the reinforcing rings, then the ratio of the effective moment of inertia for inside or outside rings to that for median-line rings for Cases 1 to 4 is 4.8, 5.2, 4.3 and 4.7, respectively, concurring with the above mentioned four to five fold increase in the deformation of median-line rings. The concept of reinforcing ring together with the full bay length as an effective width of shell has been applied (Ref. 4) to a short, oval, ring-reinforced cylinder, and good agreement with available experimental data (Ref. 2) was achieved.

The circumferential forces and bending moments in the rings at the ends of the major axis are shown in Figs. 12, 23, and 34. These figures show that the oval reinforcing rings exhibit a behavior similar to that described above for the oval shell. For example, the sign of the circumferential force changes from negative to positive (without a substantial change in absolute value) in going from inside to outside rings, whereas, by comparison the magnitude of the circumferential force is small for median-line rings. On the other hand, consistent with the larger radial deformations, the circumferential bending moment in median-line rings is approximately four to five times that in either inside or outside rings.

It is of interest to compare stresses at the point at the ring at the end of the major axis ($x = L/2$, $s = 0$), generally the most severly stressed point (discussed above), with those at the most flexible point of the cylinder, i.e., the point at mid-bay at the end of the minor axis ($x = 0$, $s = L_o/4$). Figures 4 and 8, respectively, show the axial and circumferential stresses at the latter point for inside rings and Figs. 15 and 19 show corresponding results for outside rings. In each instance the stresses are seen to be much less severe than the corresponding stresses at the ring at the end of the major axis. These figures also show that at a given point there is not always a monotonic increase in stress level with an increase in b/a. For example, Fig. 4 shows that for inside rings the axial bending stress is most severe in the range $1.25 \lesssim b/a \lesssim 1.35$ and drops off for either higher or lower values of b/a. This behavior is not exhibited for outside rings (Fig. 15). Also, Fig. 15 shows that the magnitude of the axial membrane stress decreases monotonically with b/a for outside rings; whereas, Fig. 4 shows the opposite trend for inside rings.

Regarding the relative behavior of Cases 1 to 4, a number of general conclusions can be drawn. As is well known, the behavior of ring-reinforced circular cylinders is virtually dependent only upon the cross-sectional area of the reinforcing rings and not upon their cross-sectional moment of inertia. Consequently, for circular cylinders ($b/a = 1.0$) the results for Cases 1 and 2 (identical ring areas) coincide, as do those for Cases 3 and 4 (also identical ring areas). This independence of the cross-sectional moment of inertia is not retained as b/a is increased because circumferential bending begins to play a dominant role.

In many instances, as b/a is increased, the shell stresses for Cases 1 and 3 do not differ greatly. The situation is similar for Cases 2 and 4, indicating that the radius of gyration parameter I/Ah^2, which is identical for these cases, has a dominant influence on the shell stresses in the oval cylinders considered. Such behavior is not as pronounced for median-line rings as it is for either inside or outside rings. However, this trend pertains only to the shell stresses and not to the radial displacements or the reinforcing ring forces and bending moments.

REFERENCES

1. Pulos, John G. and Salerno, Vito L.: Axisymmetric Elastic Deformations and Stresses in a Ring-Stiffened, Perfectly Circular Cylindrical Shell Under External Hydrostatic Pressure. David Taylor Model Basin Report No. 1497, September 1961.

2. Couch, William P. and Pulos, John G.: Progress Report, Experimental Stresses and Strains in a Ring-Stiffened Cylinder of Oval Cross Section (Major-to-Minor Axis Ratio of 1.5). David Taylor Model Basin Report No. 1726, March 1963.

3. Vafakos, W.P.; Romano, F. and Kempner, J.: Clamped Short Oval Cylindrical Shells under Hydrostatic Pressure. Journal of the Aerospace Sci., Vol. 29, No. 11, Nov. 1962, pp. 1347-1357; formerly PIBAL Rep. No. 594, Polytechnic Institute of Brooklyn, June 1961.

4. Vafakos, William P.: Analysis of Uniform Deep Oval Reinforcing Rings. Journal of Ship Research, Vol. 7, No. 4, April 1964, pp. 21-28; formerly PIBAL Rep. No. 678, Polytechnic Institute of Brooklyn, Feb. 1964.

5. Vafakos, W.P.; Nissel, N. and Kempner, J.: Energy Solution for Simply Supported Oval Shells. AIAA Journal (Tech. Note) Vol. 2, No. 3, March 1964, pp. 555-557; formerly PIBAL Rep. No. 667, Polytechnic Institute of Brooklyn, Aug. 1963.

6. Romano, F. and Kempner, J.: Stresses in Short Noncircular Cylindrical Shells under Lateral Pressure. J. Appl. Mech., Vol. 29, No. 4, Dec. 1962, pp. 669-674; formerly PIBAL Rep. No. 415, Polytechnic Institute of Brooklyn, July 1958.

7. Kempner, J.; Vafakos, W.P. and Nissel, N.: Reinforced Oval Cylinder--Comparison of Theory and DTMB Tests. J. Appl. Mech. (Brief Note) Vol. 31, No. 4, Dec. 1964, pp. 710-711; formerly, PIBAL Rep. No. 671, Polytechnic Institute of Brooklyn, Sept. 1963.

8. Vafakos, W.P.; Nissel, N. and Kempner, J.: Theoretical Stress Distributions for Two Ring-Reinforced Oval Cylinders. PIBAL Rep. No. 693, Polytechnic Institute of Brooklyn, May 1964.

TABLE 1

RING AND SHELL DATA FOR CASES CONSIDERED*

	CASE 1	CASE 2	CASE 3	CASE 4
Lh/A	3.5	3.5	2	2
(A/h^2)	(6.857)	(6.857)	(12)	(12)
I/Ah^2	7	10	7	10
(I/h^4)	(48)	(68.57)	(84)	(120)
	Inside rings			
$\bar{z}/h$	6	7.5	6	7.5
	Outside rings			
$\bar{z}/h$	-6	-7.5	-6	-7.5
	Median line rings			
$\bar{z}/h$	0	0	0	0

*In all cases

$L_o/L = 24$ $(r_o/L = 3.820)$, $L_o/h = 576$ $(r_o/h = 91.67)$, $\nu = 0.3$, $B = 0$

TABLE A1

AXIAL MEMBRANE STRESSES, $-(\sigma_{xm}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, $b/a = 1.1$

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
	0	309	309	310	312	316	321
	0.25	356	357	358	360	363	366
1	0.50	456	456	456	457	457	457
	0.75	557	557	556	554	551	547
	1	606	606	604	601	598	592
	0	339	339	340	342	344	349
	0.25	376	376	377	378	381	384
2	0.50	456	456	456	457	457	457
	0.75	538	538	537	535	533	530
	1	576	576	574	572	569	564
	0	316	316	317	319	322	328
	0.25	360	360	361	363	366	369
3	0.50	456	456	456	457	457	457
	0.75	554	554	553	551	548	544
	1	599	599	597	595	591	586
	0	344	344	345	347	349	354
	0.25	378	379	379	381	383	386
4	0.50	456	456	457	457	457	457
	0.75	535	535	534	533	530	528
	1	570	570	569	567	564	559
				Outside Rings			
	0	621	621	620	618	614	608
	0.25	582	582	581	579	576	571
1	0.50	457	457	456	456	456	456
	0.75	331	332	333	334	338	342
	1	292	293	294	297	302	308
	0	595	595	594	593	589	584
	0.25	561	561	560	558	556	552
2	0.50	456	456	456	456	456	456
	0.75	353	353	354	355	358	362
	1	319	319	321	323	327	332
	0	616	616	615	613	610	604
	0.25	576	576	575	573	570	566
3	0.50	457	457	456	456	456	456
	0.75	337	337	338	340	343	348
	1	297	298	299	302	306	312
	0	591	591	590	588	585	580
	0.25	556	556	555	554	551	548
4	0.50	456	456	456	456	456	456
	0.75	357	358	358	360	362	366
	1	323	323	325	327	330	336

*Case, see Table 1

TABLE A2

AXIAL BENDING STRESSES, $(\sigma_{xb}/q_o) \times 10$

FOR INSIDE AND OUTSIDE RINGS, $b/a = 1.1$

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
	0	544	487	299	-69	-690	-1634
	0.25	434	389	240	-48	-528	-1251
1	0.50	155	176	116	4	-177	-440
	0.75	-8	-2	18	56	118	213
	1	-80	-65	-15	77	224	437
	0	466	419	264	-41	-553	-1334
	0.25	380	342	216	-28	-436	-1049
2	0.50	197	178	117	2	-182	-451
	0.75	46	45	40	34	27	21
	1	-7	-1	16	48	100	179
	0	630	568	363	-39	-715	-1744
	0.25	518	467	298	-28	-570	-1386
3	0.50	271	245	160	2	-252	-624
	0.75	61	58	50	34	15	-6
	1	-16	-10	10	49	112	207
	0	549	496	322	-21	-596	-1471
	0.25	462	417	270	-15	-489	-1201
4	0.50	274	247	161	0.5	-258	-634
	0.75	119	109	77	20	-66	-185
	1	64	60	49	29	0.9	-34
				Outside Rings			
	0	-721	-666	-485	-129	472	1389
	0.25	-443	-409	-298	-83	279	828
1	0.50	194	176	117	7	-170	-428
	0.75	783	711	483	64	-596	-1547
	1	1012	918	620	78	-766	-1970
	0	-580	-534	-385	-90	407	1166
	0.25	-346	-319	-230	-57	233	675
2	0.50	190	172	114	4	-170	-425
	0.75	687	623	418	41	-552	-1406
	1	881	797	532	48	-704	-1777
	0	-578	-533	-384	-91	403	1160
	0.25	-320	-295	-215	-58	207	612
3	0.50	272	246	.62	.4	-248	-615
	0.75	819	741	494	39	-676	-1705
	1	1033	933	618	46	-846	-2116
	0	-453	-417	-298	-64	332	938
	0.25	-234	-216	-157	-40	158	460
4	0.50	267	241	158	3	-246	-611
	0.75	733	662	437	24	-626	-1561
	1	915	826	542	26	-777	-1920

*Case, see Table 1

TABLE A3

CIRCUMFERENTIAL MEMBRANE STRESSES, $(\sigma_{sm}/q_o) \times 10$

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.1

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
1	0	-533	-492	-375	-208	-39	52
	0.25	-626	-594	-507	-381	-255	-187
	0.50	-820	-809	-778	-735	-693	-673
	0.75	-1050	-1054	-1065	-1082	-1101	-1116
	1	-1178	-1187	-1212	-1248	-1287	-1314
2	0	-582	-548	-452	-314	-174	-98
	0.25	-654	-628	-554	-448	-341	-284
	0.50	-818	-807	-776	-732	-689	-668
	0.75	-1009	-1009	-1009	-1011	-1014	-1021
	1	-1109	-1113	-1124	-1139	-1158	-1173
3	0	-512	-468	-341	-159	24	122
	0.25	-594	-559	-460	-319	-177	-102
	0.50	-780	-765	-722	-662	-602	-574
	0.75	-1001	-1000	-999	-999	-1000	-1007
	1	-1117	-1121	-1134	-1153	-1174	-1193
4	0	-558	-520	-412	-258	-101	-19
	0.25	-622	-592	-506	-383	-259	-194
	0.50	-778	-763	-719	-658	-599	-570
	0.75	-960	-956	-944	-929	-916	-914
	1	-1051	-1050	-1049	-1048	-1050	-1057
				Outside Rings			
1	0	-1039	-1079	-1192	-1353	-1519	-1610
	0.25	-1014	-1038	-1104	-1200	-1297	-1352
	0.50	-818	-807	-779	-738	-698	-679
	0.75	-576	-540	-437	-293	-149	-72
	1	-506	-461	-334	-155	23	12
2	0	-1001	-1034	-1127	-1261	-1398	-1473
	0.25	-977	-996	-1049	-1126	-1204	-1249
	0.50	-820	-809	-781	-740	-701	-681
	0.75	-624	-592	-500	-370	-242	-174
	1	-563	-523	-410	-251	-932	-9
3	0	-999	-1032	-1125	-1259	-1396	-1473
	0.25	-966	-983	-1032	-1103	-1176	-1218
	0.50	-778	-763	-722	-664	-606	-578
	0.75	-545	-506	-396	-239	-84	-3
	1	-468	-420	-287	-99	89	188
4	0	-961	-988	-1062	-1169	-1280	-1342
	0.25	-932	-945	-981	-1034	-1089	-1122
	0.50	-780	-765	-724	-667	-610	-582
	0.75	-591	-555	-455	-313	-173	-100
	1	-525	-482	-362	-193	-25	63

*Case, see Table 1

TABLE A4

CIRCUMFERENTIAL BENDING STRESSES, $(\sigma_{sb}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.1

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
1	0	-90	-107	-165	-278	-467	-751
	0.25	-40	-54	-99	-187	-332	-550
	0.50	71	66	48	15	-39	-118
	0.75	168	170	177	189	209	238
	1	203	208	224	254	299	364
2	0	-19	-34	-82	-175	-331	-566
	0.25	7	-5	-43	-118	-241	-425
	0.50	67	61	43	9	-46	-126
	0.75	121	121	120	119	118	117
	1	142	144	150	160	177	201
3	0	25	5	-58	-181	-386	-696
	0.25	44	29	-22	-121	-285	-531
	0.50	90	82	56	10	-66	-177
	0.75	129	128	126	123	119	113
	1	143	146	153	166	186	215
4	0	62	46	-8	-112	-286	-550
	0.25	69	55	10	-76	-219	-433
	0.50	86	78	53	5	-72	-184
	0.75	105	102	93	77	52	17
	1	113	112	110	104	97	87
				Outside Rings			
1	0	-566	-549	-492	-381	-197	80
	0.25	-363	-352	-318	-250	-139	27
	0.50	83	77	59	26	-28	-106
	0.75	465	443	373	244	44	-242
	1	605	576	484	319	62	-300
2	0	-412	-398	-351	-259	-106	124
	0.25	-260	-252	-224	-169	-80	54
	0.50	74	69	51	18	-35	-112
	0.75	363	343	280	164	-16	-273
	1	469	443	361	213	-15	-338
3	0	-415	-401	-353	-262	-109	120
	0.25	-254	-246	-220	-171	-89	34
	0.50	99	91	66	18	-58	-168
	0.75	404	380	304	165	-52	-362
	1	516	485	389	214	-57	-439
4	0	-302	-290	-252	-179	-56	127
	0.25	-179	-173	-154	-116	-55	37
	0.50	93	85	60	13	-62	-172
	0.75	328	307	238	111	-86	-367
	1	415	388	301	143	-100	-444

*Case, see Table 1

TABLE A5

SHEAR MEMBRANE STRESSES. $(\tau_{xsm}/q_o) \times 10^2$,

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.1

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
	0	0	0	0	0	0	0
	0.25	0	100	224	390	608	867
1	0.50	0	167	360	599	892	1231
	0.75	0	136	285	456	654	874
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	84	185	318	491	696
2	0.50	0	138	295	486	720	988
	0.75	0	111	232	369	527	701
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	95	212	372	581	831
3	0.50	0	159	342	571	854	1182
	0.75	0	130	272	436	628	842
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	79	176	304	472	670
4	0.50	0	130	280	464	689	949
	0.75	0	105	220	352	504	672
	1	0	0	0	0	0	0
				Outside Rings			
	0	0	0	0	0	0	0
	0.25	0	-90	-218	-415	-695	-1041
1	0.50	0	-158	-360	-639	-1010	-1454
	0.75	0	-134	-291	-488	-733	-1016
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-73	-178	-344	-580	-873
2	0.50	0	-129	-295	-528	-839	-1214
	0.75	0	-110	-239	-403	-607	-843
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-87	-211	-400	-668	-999
3	0.50	0	-154	-350	-618	-974	-1398
	0.75	0	-131	-283	-474	-708	-978
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-71	-174	-332	-559	-839
4	0.50	0	-126	-288	-512	-810	-1168
	0.75	0	-107	-233	-391	-587	-814
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE A6

SHEAR BENDING STRESSES, $(\tau_{xsb}/q_o) \times 10^2$,

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.1

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
	0	0	0	0	0	0	0
	0.25	0	-115	-208	-252	-202	0
1	0.50	0	-139	-250	-299	-237	0
	0.75	0	-82	-146	-172	-134	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-86	-156	-188	-151	0
2	0.50	0	-102	-184	-220	-175	0
	0.75	0	-58	-104	-123	-957	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-109	-198	-240	-193	0
3	0.50	0	-133	-240	-288	-229	0
	0.75	0	-79	-141	-167	-130	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-82	-149	-181	-146	0
4	0.50	0	-98	-177	-212	-169	0
	0.75	0	-56	-101	-119	-93	0
	1	0	0	0	0	0	0
				Outside Rings			
	0	0	0	0	0	0	0
	0.25	0	203	366	439	349	0
1	0.50	0	269	482	571	448	0
	0.75	0	178	316	369	284	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	175	317	380	302	0
2	0.50	0	233	418	494	387	0
	0.75	0	154	274	319	246	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	195	353	422	336	0
3	0.50	0	259	464	549	430	0
	0.75	0	171	303	354	272	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	169	305	365	290	0
4	0.50	0	225	402	475	372	0
	0.75	0	148	263	306	236	0
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE A7

RADIAL DEFORMATIONS, $(Ew/q_o h) \times 10^{-2}$,

FOR INSIDE AND OUTSIDE RINGS, $b/a = 1.1$

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
	0	-887	-890	-899	-912	-925	-931
	0.25	-578	-580	-587	-597	-607	-612
1	0.50	150	149	146	142	138	136
	0.75	850	850	851	853	854	855
	1	1132	1133	1135	1139	1142	1143
	0	-536	-539	-547	-557	-568	-573
	0.25	-342	-344	-350	-358	-367	-371
2	0.50	117	116	113	109	106	104
	0.75	560	560	560	560	560	560
	1	739	739	740	741	742	743
	0	-558	-561	-571	-586	-600	-606
	0.25	-357	-360	-368	-379	-391	-396
3	0.50	116	115	111	105	100	97
	0.75	572	572	571	571	570	570
	1	756	756	757	758	759	760
	0	-328	-331	-339	-351	-363	-369
	0.25	-202	-205	-212	-222	-232	-237
4	0.50	94	92	89	83	78	75
	0.75	381	381	379	378	376	375
	1	498	498	497	496	496	495
				Outside Rings			
	0	-1237	-1234	-1225	-1212	-1200	-1194
	0.25	-810	-808	-803	-795	-788	-784
1	0.50	184	183	180	176	172	171
	0.75	1126	1123	1112	1098	1084	1078
	1	1502	1497	1484	1466	1448	1439
	0	-821	-819	-811	-801	-791	-786
	0.25	-531	-529	-525	-519	-513	-510
2	0.50	145	144	142	138	134	132
	0.75	785	782	773	760	748	741
	1	1040	1036	1024	1008	992	984
	0	-836	-834	-826	-816	-806	-801
	0.25	-542	-540	-537	-531	-526	-523
3	0.50	143	141	137	132	127	124
	0.75	790	786	775	759	744	737
	1	1047	1042	1028	1009	990	981
	0	-555	-553	-547	-539	-530	-526
	0.25	-353	-352	-349	-345	-340	-338
4	0.50	116	115	111	106	101	98
	0.75	559	556	546	532	518	511
	1	735	730	718	700	683	675

*Case, see Table 1

TABLE A8

CIRCUMFERENTIAL DEFORMATIONS, $(Ev/q_o h) \times 10^{-2}$

FOR INSIDE AND OUTSIDE RINGS, $b/a = 1.1$

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
	0	0	0	0	0	0	0
	0.25	-364	-363	-363	-363	-363	-362
1	0.50	-483	-483	-483	-483	-482	-482
	0.75	-320	-320	-320	-320	-319	-319
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-227	-227	-226	-226	-226	-226
2	0.50	-301	-301	-301	-301	-300	-300
	0.75	-199	-199	-199	-199	-199	-198
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-233	-233	-233	-233	-232	-232
3	0.50	-309	-309	-309	-309	-308	-308
	0.75	-204	-204	-204	-204	-204	-203
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-144	-144	-143	-143	-143	-143
4	0.50	-191	-190	-190	-190	-190	-189
	0.75	-126	-126	-126	-126	-125	-125
	1	0	0	0	0	0	0
				Outside Rings			
	0	0	0	0	0	0	0
	0.25	-515	-515	-515	-515	-516	-516
1	0.50	-685	-685	-685	-686	-686	-687
	0.75	-454	-454	-454	-455	-455	-456
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-350	-350	-350	-350	-350	-351
2	0.50	-466	-466	-466	-466	-466	-467
	0.75	-309	-309	-309	-309	-309	-310
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-356	-356	-356	-356	-356	-357
3	0.50	-473	-473	-474	-474	-474	-475
	0.75	-314	-314	-314	-314	-314	-315
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-244	-244	-244	-244	-244	-245
4	0.50	-324	-324	-324	-325	-325	-326
	0.75	-215	-215	-215	-215	-215	-216
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE A9

AXIAL MEMBRANE STRESSES, $-(\sigma_{xm}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.2

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
	0	166	166	167	170	174	184
	0.25	278	278	281	285	290	298
1	0.50	452	452	453	454	456	457
	0.75	636	635	633	629	623	615
	1	758	757	754	749	741	730
	0	218	218	219	221	225	233
	0.25	307	307	309	312	317	324
2	0.50	452	453	453	454	455	455
	0.75	599	598	596	593	588	582
	1	688	688	685	681	676	668
	0	180	180	181	184	188	197
	0.25	276	277	279	283	288	296
3	0.50	448	448	449	450	452	452
	0.75	629	629	627	623	617	610
	1	736	735	732	727	719	709
	0	231	231	232	234	238	246
	0.25	309	310	311	315	319	325
4	0.50	453	453	454	455	455	455
	0.75	596	596	594	591	586	580
	1	674	673	671	668	662	654
				Outside Rings			
	0	733	732	731	728	722	711
	0.25	710	709	707	704	697	688
1	0.50	456	456	454	453	452	451
	0.75	196	196	198	202	208	217
	1	166	167	171	177	186	198
	0	693	693	692	689	684	675
	0.25	664	664	662	659	654	646
2	0.50	454	453	452	451	450	450
	0.75	241	242	243	246	252	259
	1	211	212	214	219	226	236
	0	731	731	730	727	722	711
	0.25	694	694	692	688	682	673
3	0.50	456	455	454	452	451	450
	0.75	211	212	214	218	224	232
	1	169	170	173	179	187	199
	0	690	690	690	687	682	673
	0.25	652	652	650	647	642	635
4	0.50	454	453	452	451	450	450
	0.75	253	254	256	259	264	271
	1	214	214	217	222	228	238

*Case, see Table 1

TABLE 10

AXIAL BENDING STRESSES, $(\sigma_{xb}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.2

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
	0	905	816	510	-114	-1206	-2918
	0.25	671	604	378	-77	-860	-2072
1	0.50	203	185	126	14	-165	-427
	0.75	-128	-105	-30	109	330	652
	1	-226	-187	-66	149	476	934
	0	764	692	444	-64	-951	-2343
	0.25	569	514	329	-43	-684	-1675
2	0.50	196	177	119	9	-167	-422
	0.75	-38	-28	5	67	169	322
	1	-94	-75	-14	92	254	481
	0	989	897	584	-55	-1175	-2929
	0.25	752	681	441	-39	-865	-2142
3	0.50	272	247	164	9	-240	-604
	0.75	-78	-63	-17	70	210	420
	1	-185	-155	-64	98	346	694
	0	842	766	506	-25	-955	-2412
	0.25	645	585	384	-18	-711	-1781
4	0.50	265	240	158	5	-239	-595
	0.75	22	23	28	41	66	113
	1	-39	-29	3	55	145	266
				Outside Rings			
	0	-1513	-1405	-1038	-287	1028	3093
	0.25	-981	-908	-664	-173	673	1986
1	0.50	218	199	137	24	-157	-421
	0.75	1296	1175	796	111	-948	-2451
	1	1707	1541	1027	115	-1265	-3181
	0	-1247	-1156	-844	-206	911	2664
	0.25	-796	-735	-532	-123	583	1679
2	0.50	218	198	135	17	-171	-446
	0.75	1125	1017	679	68	-875	-2213
	1	1469	1323	869	64	-1152	-2840
	0	-1311	-1214	-885	-211	969	2824
	0.25	-813	-752	-544	-125	599	1724
3	0.50	303	275	185	17	-252	-643
	0.75	1300	1174	779	65	-1038	-2602
	1	1677	1509	985	58	-1346	-3294
	0	-1076	-995	-718	-153	837	2392
	0.25	-651	-601	-431	-89	502	1422
4	0.50	300	272	181	12	-259	-654
	0.75	1146	1033	678	37	-953	-2356
	1	1466	1316	850	25	-1221	-2951

*Case, see Table 1

TABLE A11

CIRCUMFERENTIAL MEMBRANE STRESSES, $(\sigma_{sm}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.2

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
1	0	-299	-221	-0.4	319	646	823
	0.25	-522	-468	-316	-98	125	246
	0.50	-815	-804	-772	-727	-682	-661
	0.75	-1251	-1263	-1297	-1347	-1400	-1437
	1	-1616	-1634	-1684	-1755	-1831	-1884
2	0	-385	-321	-142	119	386	530
	0.25	-559	-515	-391	-212	-30	68
	0.50	-819	-808	-777	-734	-692	-672
	0.75	-1176	-1182	-1199	-1224	-1252	-1275
	1	-1448	-1457	-1484	-1524	-1567	-1600
3	0	-310	-230	-4	323	657	837
	0.25	-485	-429	-269	-39	195	320
	0.50	-780	-764	-721	-659	-599	-570
	0.75	-1208	-1216	-1239	-1272	-1310	-1339
	1	-1518	-1532	-1571	-1628	-1689	-1734
4	0	-385	-319	-131	141	420	570
	0.25	-526	-479	-345	-153	43	148
	0.50	-784	-769	-727	-668	-610	-583
	0.75	-1131	-1133	-1139	-1150	-1163	-1179
	1	-1362	-1368	-1385	-1411	-1440	-1466
				Outside Rings			
1	0	-1046	-1140	-1404	-1787	-2180	-2393
	0.25	-1196	-1254	-1417	-1653	-1894	-2026
	0.50	-794	-784	-756	-717	-678	-659
	0.75	-228	-174	-24	189	400	515
	1	-214	-149	34	292	548	689
2	0	-1012	-1091	-1316	-1641	-1975	-2156
	0.25	-1114	-1162	-1299	-1495	-1696	-1806
	0.50	-796	-786	-756	-715	-673	-653
	0.75	-344	-296	-163	26	214	315
	1	-312	-254	-94	132	357	479
3	0	-1030	-1114	-1352	-1696	-2050	-2243
	0.25	-1124	-1173	-1313	-1515	-1723	-1838
	0.50	-752	-737	-694	-635	-576	-547
	0.75	-220	-165	-8	212	432	549
	1	-154	-88	98	359	619	760
4	0	-991	-1061	-1260	-1549	-1846	-2008
	0.25	-1052	-1092	-1206	-1372	-1542	-1636
	0.50	-756	-740	-697	-636	-576	-546
	0.75	-327	-277	-137	60	256	361
	1	-257	-198	34	198	427	550

*Case, see Table 1

TABLE A12

CIRCUMFERENTIAL BENDING STRESSES. $(\sigma_{sb}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, b/a - 1.2

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
1	0	-223	-251	-346	-539	-872	-1388
	0.25	-119	-140	-209	-348	-585	-950
	0.50	103	98	81	49	-3	-80
	0.75	282	289	314	358	426	524
	1	343	355	393	459	559	697
2	0	-85	-108	-186	-342	-612	-1032
	0.25	-32	-49	-106	-219	-413	-712
	0.50	86	81	65	34	-17	-93
	0.75	191	195	206	226	259	306
	1	231	237	256	288	338	406
3	0	-25	-54	-151	-348	-689	-1218
	0.25	17	-5	-78	-225	-475	-859
	0.50	109	102	78	33	-40	-148
	0.75	185	190	206	234	278	343
	1	212	221	250	300	376	482
4	0	49	25	-56	-219	-502	-941
	0.25	62	44	-18	-140	-350	-672
	0.50	97	90	67	22	-49	-155
	0.75	138	139	141	147	156	171
	1	156	160	170	188	214	251
				Outside Rings			
1	0	-1144	-1110	-995	-762	-359	264
	0.25	-727	-704	-628	-475	-217	179
	0.50	144	138	119	84	28	-52
	0.75	822	784	667	457	134	-319
	1	1046	995	836	557	137	-440
2	0	-847	-818	-720	-522	-179	350
	0.25	-533	-514	-450	-323	-107	224
	0.50	122	116	96	60	2	-80
	0.75	632	598	494	307	19	-384
	1	800	755	615	369	-0.7	-509
3	0	-873	-842	-738	-528	-166	394
	0.25	-542	-522	-456	-326	-104	235
	0.50	150	141	113	62	-20	-138
	0.75	688	649	527	308	-28	-499
	1	866	814	653	369	-57	-644
4	0	-654	-628	-540	-364	-60	410
	0.25	-399	-383	-329	-223	-41	236
	0.50	133	124	96	44	-38	-158
	0.75	548	513	404	207	-94	-517
	1	686	640	496	244	-134	-655

*Case, see Table 1

TABLE A13

SHEAR MEMBRANE STRESSES, $(\tau_{xsm}/q_o) \times 10^2$,

FOR INSIDE AND OUTSIDE RINGS, b/a - 1.2

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
		Inside Rings					
	0	0	0	0	0	0	0
	0.25	0	152	357	659	1078	1594
1	0.50	0	316	679	1130	1686	2329
	0.75	0	294	604	939	1306	1700
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	135	313	567	916	1341
2	0.50	0	260	556	918	1361	1871
	0.75	0	232	473	732	1010	1305
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	145	341	631	1034	1529
3	0.50	0	300	647	1079	1616	2236
	0.75	0	279	574	896	1251	1634
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	130	300	546	884	1298
4	0.50	0	246	528	876	1305	1799
	0.75	0	218	447	693	961	1246
	1	0	0	0	0	0	0
		Outside Rings					
	0	0	0	0	0	0	0
	0.25	0	-132	-346	-707	-1247	-1930
1	0.50	0	-302	-685	-1212	-1912	-2750
	0.75	0	-295	-623	-1007	-1457	-1959
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-108	-286	-593	-1056	-1643
2	0.50	0	-246	-562	-1001	-1590	-2297
	0.75	0	-241	-508	-823	-1193	-1606
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-129	-336	-686	-1206	-1865
3	0.50	0	-295	-666	-1174	-1845	-2646
	0.75	0	-288	-605	-974	-1402	-1878
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-106	-279	-575	-1020	-1585
4	0.50	0	-242	-548	-972	-1536	-2212
	0.75	0	-236	-496	-800	-1153	-1544
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE A14

SHEAR BENDING STRESSES, $(\tau_{xsb}/q_o) \times 10^2$,

FOR INSIDE AND OUTSIDE RINGS, b/a - 1.2

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
		Inside Rings					
	0	0	0	0	0	0	0
	0.25	0	-239	-437	-533	-433	0
1	0.50	0	-254	-459	-551	-438	0
	0.75	0	-121	-213	-246	-187	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-189	-345	-421	-343	0
2	0.50	0	-186	-337	-406	-324	0
	0.75	0	-75	-132	-152	-115	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-226	-413	-505	-411	0
3	0.50	0	-243	-440	-529	-422	0
	0.75	0	-119	-210	-243	-186	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-180	-330	-404	-329	0
4	0.50	0	-179	-324	-391	-313	0
	0.75	0	-73	-129	-149	-114	0
	1	0	0	0	0	0	0
		Outside Rings					
	0	0	0	0	0	0	0
	0.25	0	380	692	840	678	0
1	0.50	0	500	896	1062	835	0
	0.75	0	327	574	663	503	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	333	606	735	593	0
2	0.50	0	433	776	920	723	0
	0.75	0	280	492	567	429	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	371	674	818	659	0
3	0.50	0	481	861	1020	801	0
	0.75	0	309	543	626	473	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	324	589	714	575	0
4	0.50	0	417	747	884	694	0
	0.75	0	266	467	537	406	0
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE A15

RADIAL DEFORMATIONS, $(Ew/q_o h) \times 10^{-2}$ AND $(Ew/q_o h) \times 10^{-3}$, FOR INSIDE AND OUTSIDE RINGS, RESPECTIVELY, b/a = 1.2

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
		Inside Rings					
1	0	-1619	-1624	-1640	-1662	-1685	-1696
	0.25	-1018	-1022	-1033	-1049	-1066	-1074
	0.50	371	370	367	364	360	358
	0.75	1672	1674	1677	1682	1686	1689
	1	2186	2188	2193	2200	2207	2210
2	0	-1003	-1008	-1020	-1038	-1057	-1066
	0.25	-621	-624	-634	-647	-660	-667
	0.50	260	259	256	253	249	247
	0.75	1083	1083	1085	1087	1089	1090
	1	1407	1408	1410	1414	1417	1419
3	0	-1033	-1039	-1055	-1078	-1101	-1112
	0.25	-642	-646	-658	-675	-692	-701
	0.50	262	261	257	252	246	244
	0.75	1109	1110	1112	1115	1118	1119
	1	1443	1444	1448	1454	1459	1462
4	0	-630	-634	-648	-667	-686	-696
	0.25	-382	-386	-396	-410	-425	-432
	0.50	188	187	183	178	173	170
	0.75	722	722	722	723	723	723
	1	932	932	934	936	937	938
		Outside Rings					
1	0	-225	-225	-223	-220	-217	-216
	0.25	-142	-141	-140	-138	-136	-136
	0.50	48	48	48	48	47	47
	0.75	222	222	220	218	215	214
	1	289	288	286	283	280	279
2	0	-152	-151	-149	-147	-145	-144
	0.25	-94	-94	-93	-92	-90	-89
	0.50	35	35	35	34	34	34
	0.75	153	152	151	149	147	146
	1	198	197	196	193	190	189
3	0	-154	-154	-152	-149	-147	-146
	0.25	-96	-96	-95	-93	-92	-91
	0.50	35	35	34	34	33	33
	0.75	154	153	152	149	147	146
	1	200	199	197	194	191	189
4	0	-104	-104	-102	-100	-98	-97
	0.25	-64	-64	-63	-62	-60	-60
	0.50	26	26	25	25	24	24
	0.75	107	107	105	103	101	100
	1	138	138	136	133	130	129

*Case, see Table 1

TABLE A16

CIRCUMFERENTIAL DEFORMATIONS, $(Ev/q_o h) \times 10^{-2}$, FOR INSIDE AND OUTSIDE RINGS, b/a = 1.2

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
		Inside Rings					
1	0	0	0	0	0	0	0
	0.25	-704	-704	-704	-704	-703	-702
	0.50	-886	-886	-886	-886	-885	-883
	0.75	-550	-550	-549	-549	-548	-547
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	-441	-441	-441	-441	-440	-439
	0.50	-554	-554	-554	-553	-552	-551
	0.75	-342	-342	-342	-342	-341	-340
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	-452	-452	-452	-451	-451	-450
	0.50	-567	-567	-567	-566	-566	-564
	0.75	-350	-350	-350	-350	-349	-348
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	-280	-280	-280	-280	-279	-278
	0.50	-350	-350	-350	-350	-349	-348
	0.75	-216	-216	-215	-215	-214	-214
	1	0	0	0	0	0	0
		Outside Rings					
1	0	0	0	0	0	0	0
	0.2‾	-996	-996	-996	-996	-997	-998
	0.50	-1258	-1258	-1258	-1259	-1260	-1262
	0.75	-783	-783	-784	-784	-785	-786
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	-678	-678	-678	-678	-679	-680
	0.50	-856	-856	-856	-856	-857	-858
	0.75	-532	-532	-532	-533	-534	-534
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	-689	-689	-689	-689	-690	-691
	0.50	-870	-870	-870	-871	-872	-873
	0.75	-541	-541	-542	-542	-543	-544
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	-472	-472	-472	-473	-473	-474
	0.50	-596	-596	-596	-597	-598	-599
	0.75	-371	-371	-371	-371	-372	-373
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE A17

AXIAL MEMBRANE STRESSES. $-(\sigma_{xm}/q_o) \times 10$.

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.3

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
		Inside Rings					
	0	22	22	21	22	26	37
	0.25	210	212	216	222	231	243
1	0.50	430	431	433	436	440	442
	0.75	683	682	678	672	662	651
	1	906	904	900	893	882	866
	0	111	111	111	112	116	125
	0.25	250	251	254	260	267	276
2	0.50	437	437	439	441	444	445
	0.75	644	643	640	634	626	617
	1	802	801	798	793	784	772
	0	54	54	53	54	58	69
	0.25	208	210	213	219	228	239
3	0.50	431	432	434	437	440	443
	0.75	685	684	681	674	666	655
	1	871	869	865	858	848	833
	0	135	135	135	136	140	148
	0.25	250	251	254	259	266	275
4	0.50	437	438	440	442	444	445
	0.75	644	643	640	635	628	619
	1	778	776	773	768	760	748
		Outside Rings					
	0	788	788	787	784	777	763
	0.25	841	840	838	832	823	811
1	0.50	462	461	458	455	452	449
	0.75	52	53	56	62	70	83
	1	76	78	84	94	107	126
	0	746	746	746	744	738	725
	0.25	770	770	767	762	755	744
2	0.50	454	453	451	448	446	445
	0.75	124	124	127	131	139	150
	1	134	135	140	147	158	173
	0	798	798	797	795	788	775
	0.25	813	812	809	803	794	782
3	0.50	459	458	456	452	449	447
	0.75	81	82	85	90	99	112
	1	72	74	79	88	101	118
	0	752	752	752	750	745	733
	0.25	748	747	745	740	732	722
4	0.50	452	452	450	447	445	444
	0.75	146	147	149	154	161	172
	1	130	132	136	143	153	167

*Case, see Table 1

TABLE A18

AXIAL BENDING STRESSES, $(\sigma_{xb}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.3

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
		Inside Rings					
	0	1242	1127	725	-132	-1688	-4192
	0.25	883	799	511	-89	-1157	-2853
1	0.50	215	197	138	26	-155	-417
	0.75	-171	-138	-36	154	453	890
	1	-248	-199	-49	211	590	1100
	0	1030	939	618	-67	-1309	-3308
	0.25	739	671	439	-46	-909	-2277
2	0.50	214	195	133	16	-172	-444
	0.75	-58	-43	4	94	241	462
	1	-96	-72	3	13	317	565
	0	1315	1201	802	-51	-1599	-4090
	0.25	957	871	576	-37	-1127	-2854
3	0.50	277	251	170	17	-230	-588
	0.75	-141	-117	-42	99	325	658
	1	-237	-197	-72	141	454	877
	0	1093	1001	677	-13	-1267	-3285
	0.25	806	736	493	-12	-909	-2330
4	0.50	280	253	169	10	-245	-616
	0.75	-14	-7	14	58	135	259
	1	-66	-5	0.3	86	210	375
		Outside Rings					
	0	-2139	-2000	-1507	-455	1460	4548
	0.25	-1430	-1330	-984	-267	1007	3025
1	0.50	196	181	131	42	-98	-299
	0.75	1701	1540	1039	145	-1216	-3123
	1	2288	2059	1354	128	-1684	-4146
	0	-1786	-1665	-1241	-335	1313	3970
	0.25	-1171	-1087	-797	-193	879	2580
2	0.50	219	200	140	31	-142	-393
	0.75	1475	1332	885	87	-1127	-2828
	1	1957	1755	1137	62	-1525	-3678
	0	-1900	-1770	-1316	-345	1420	4268
	0.25	-1222	-1134	-831	-198	928	2716
3	0.50	305	278	191	31	-223	-591
	0.75	1681	1516	1001	815	-1319	-3278
	1	2207	1978	1274	50	-1756	-4209
	0	-1584	-1474	-1086	-258	1248	3675
	0.25	-996	-923	-671	-145	791	2280
4	0.50	318	288	195	22	-252	-653
	0.75	1479	1331	868	44	-1211	-2968
	1	1916	1713	1091	10	-1584	-3746

*Case, see Table 1

TABLE A19

CIRCUMFERENTIAL MEMBRANE STRESSES. $(\sigma_{sm}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, $b/a = 1.3$

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
		Inside Rings					
	0	-100	17	349	834	1335	1604
	0.25	-492	-416	-200	113	436	611
1	0.50	-793	-780	-745	-696	-647	-621
	0.75	-1408	-1423	-1465	-1527	-1593	-1641
	1	-2113	-2133	-2189	-2269	-2356	-2422
	0	-238	-145	121	509	910	1126
	0.25	-514	-452	-278	-25	236	377
2	0.50	-800	-788	-753	-704	-656	-631
	0.75	-1318	-1325	-1348	-1381	-1418	-1450
	1	-1824	-1835	-1866	-1913	-1965	-2009
	0	-153	-36	294	776	1274	1541
	0.25	-441	-364	-143	176	504	681
3	0.50	-769	-752	-707	-642	-579	-546
	0.75	-1387	-1398	-1431	-1479	-1533	-1574
	1	-1965	-1982	-2030	-2099	-2175	-2234
	0	-270	-175	93	484	888	1105
	0.25	-472	-409	-227	35	305	451
4	0.50	-772	-755	-710	-645	-582	-550
	0.75	-1286	-1291	-1304	-1324	-1350	-1374
	1	-1704	-1712	-1737	-1773	-1815	-1853
		Outside Rings					
	0	-883	-1026	-1434	-2028	-2642	-2972
	0.25	-1393	-1484	-1740	-2113	-2497	-2705
1	0.50	-764	-757	-738	-712	-648	-677
	0.75	200	263	439	688	937	1074
	1	24	99	308	603	897	1065
	0	-886	-1010	-1360	-1872	-2401	-2686
	0.25	-1262	-1338	-1554	-1868	-2190	-2366
2	0.50	-765	-756	-731	-695	-660	-644
	0.75	3	59	216	437	658	778
	1	-103	-38	145	401	657	800
	0	-911	-1043	-1419	-1968	-2536	-2843
	0.25	-1285	-1365	-1592	-1922	-2263	-2450
3	0.50	-718	-705	-667	-614	-563	-539
	0.75	173	238	419	674	929	1068
	1	124	199	407	700	993	1158
	0	-900	-1012	-1333	-1801	-2286	-2549
	0.25	-1173	-1239	-1428	-1702	-1985	-2140
4	0.50	-722	-707	-665	-606	-547	-519
	0.75	-7	51	213	441	668	791
	1	-16	50	233	490	746	888

*Case, see Table 1

TABLE A20

CIRCUMFERENTIAL BENDING STRESSES, $(\sigma_{sb}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, $b/a = 1.3$

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
		Inside Rings					
	0	-336	-373	-499	-765	-1240	-1996
	0.25	-185	-210	-299	-483	-807	-1317
1	0.50	138	133	118	88	37	-39
	0.75	398	409	442	502	595	728
	1	488	503	549	628	743	896
	0	-140	-168	-269	-481	-860	-1464
	0.25	-63	-84	-155	-303	-565	-976
2	0.50	110	105	88	56	3	-77
	0.75	268	272	288	318	364	432
	1	328	336	359	397	453	528
	0	-68	-104	-229	-493	-965	-1717
	0.25	-6	-32	-123	-310	-640	-1160
3	0.50	132	125	102	60	-11	-117
	0.75	250	258	283	329	400	502
	1	294	307	345	411	506	633
	0	38	9	-92	-306	-688	-1297
	0.25	57	36	-39	-193	-464	-892
4	0.50	113	106	82	37	-36	-146
	0.75	181	183	191	207	232	270
	1	212	218	233	259	297	347
		Outside Rings					
	0	-1635	-1590	-1436	-1109	-524	408
	0.25	-1034	-1002	-894	-672	-283	325
1	0.50	196	192	176	148	105	44
	0.75	1115	1065	910	636	220	-355
	1	1405	1334	1116	740	188	-554
	0	-1221	-1182	-1049	-768	-263	538
	0.25	-763	-736	-645	-458	-131	382
2	0.50	168	162	144	110	56	-20
	0.75	854	810	672	427	57	-456
	1	1067	1004	814	484	2	-647
	0	-1263	-1222	-1079	-777	-236	623
	0.25	-783	-755	-659	-463	-119	420
3	0.50	196	188	161	112	34	-78
	0.75	921	869	710	428	2	-589
	1	1146	1075	858	483	-66	-805
	0	-957	-922	-799	-541	-80	654
	0.25	-584	-561	-481	-318	-32	418
4	0.50	173	164	136	82	-2	-124
	0.75	729	683	540	288	-94	-624
	1	900	838	646	316	-168	-820

*Case, see Table 1

TABLE A21

SHEAR MEMBRANE STRESSES, $(\tau_{xsm}/q_o) \times 10^2$.

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.3

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
	0	0	0	0	0	0	0
	0.25	0	156	397	794	1381	2122
1	0.50	0	445	957	1593	2379	3289
	0.75	0	473	956	1458	1983	2530
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	143	351	681	1159	1758
2	0.50	0	365	782	1293	1920	2643
	0.75	0	374	755	1148	1556	1979
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	153	388	771	1336	2049
3	0.50	0	424	913	1524	2281	3160
	0.75	0	446	904	1384	1890	2420
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	138	338	655	1115	1692
4	0.50	0	347	745	1236	1841	2541
	0.75	0	353	716	1093	1489	1902
	1	0	0	0	0	0	0
				Outside Rings			
	0	0	0	0	0	0	0
	0.25	0	-138	-396	-874	-1620	-2582
1	0.50	0	-433	-976	-1720	-2704	-3883
	0.75	0	-474	-984	-1558	-2204	-2910
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-115	-337	-752	-1406	-2250
2	0.50	0	-353	-802	-1423	-2252	-3248
	0.75	0	-384	-797	-1260	-1779	-2343
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-137	-391	-859	-1588	-2527
3	0.50	0	-424	-952	-1669	-2614	-3741
	0.75	0	-462	-955	-1501	-2108	-2764
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-114	-331	-736	-1371	-2191
4	0.50	0	-347	-784	-1384	-2179	-3131
	0.75	0	-377	-778	-1221	-1710	-2237
	1	0	0	0	0	0	0

*Case. see Table 1

TABLE A22

SHEAR BENDING STRESSES, $(\tau_{xsb}/q_o) \times 10^2$,

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.3

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
	0	0	0	0	0	0	0
	0.25	0	-360	-662	-815	-669	0
1	0.50	0	-340	-617	-744	-597	0
	0.75	0	-121	-210	-237	-175	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-278	-511	-630	-518	0
2	0.50	0	-248	-451	-546	-440	0
	0.75	0	-73	-127	-142	-104	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-337	-620	-766	-630	0
3	0.50	0	-325	-290	-714	-574	0
	0.75	0	-123	-215	-244	-181	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-259	-478	-592	-488	0
4	0.50	0	-238	-432	-525	-424	0
	0.75	0	-77	-133	-151	-112	0
	1	0	0	0	0	0	0
				Outside Rings			
	0	0	0	0	0	0	0
	0.25	0	500	919	1130	926	0
1	0.50	0	686	1231	1464	1154	0
	0.75	0	470	822	941	706	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	448	823	1010	827	0
2	0.50	0	596	1070	1272	1002	0
	0.75	0	395	690	788	590	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	500	916	1124	919	0
3	0.50	0	660	1184	1406	1107	0
	0.75	0	434	758	865	647	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	445	815	998	815	0
4	0.50	0	574	1029	1221	960	0
	0.75	0	367	640	729	545	0
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE A23

RADIAL DEFORMATIONS, $(Ew/q_o h) \cdot 10^{-2}$,

FOR INSIDE AND OUTSIDE RINGS. b/a = 1.3

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
1	0	-2154	-2162	-2183	-2215	-2246	-2262
	0.25	-1294	-1300	-1315	-1337	-1359	-1370
	0.50	671	670	668	664	660	658
	0.75	2483	2485	2490	2496	2502	2505
	1	3189	3191	3197	3206	3214	3218
2	0	-1340	-1346	-1363	-1388	-1414	-1426
	0.25	-796	-800	-812	-830	-848	-857
	0.50	449	448	445	441	437	435
	0.75	1598	1599	1601	1604	1607	1608
	1	2046	2047	2050	2054	2058	2060
3	0	-1381	-1389	-1410	-1442	-1473	-1489
	0.25	-821	-826	-842	-864	-886	-897
	0.50	461	460	456	451	445	443
	0.75	1641	1642	1645	1650	1655	1657
	1	2099	2101	2106	2113	2120	2123
4	0	-846	-852	-870	-895	-921	-933
	0.25	-494	-499	-511	-530	-548	-557
	0.50	312	311	307	301	296	293
	0.75	1058	1058	1059	1061	1062	1063
	1	1349	1350	1352	1354	1357	1358
				Outside Rings			
1	0	-2998	-2988	-2962	-2923	-2884	-2864
	0.25	-1800	-1794	-1776	-1750	-1724	-1711
	0.50	886	885	883	880	877	876
	0.75	3284	3276	3255	3225	3196	3182
	1	4192	4182	4153	4112	4073	4055
2	0	-2034	-2026	-2003	-1969	-1936	-1919
	0.25	-1209	-1204	-1188	-1167	-1144	-1134
	0.50	629	628	626	622	618	616
	0.75	2252	2245	2226	2199	2173	2161
	1	2861	2852	2826	2790	2756	2740
3	0	-2064	-2055	-2030	-1995	-1959	-1941
	0.25	-1229	1223	-1207	-1184	-1161	-1150
	0.50	630	629	625	619	614	611
	0.75	2268	2260	2238	2208	2178	2164
	1	2883	2872	2843	2802	2764	2745
4	0	-1406	-1399	-1378	-1347	-1316	-1301
	0.25	-827	-823	-810	-790	-771	-762
	0.50	454	452	448	442	436	433
	0.75	1570	1563	1544	1516	1489	1476
	1	1985	1976	1950	1914	1880	1864

*Case, see Table 1

TABLE A24

CIRCUMFERENTIAL DEFORMATIONS, $(Ev/q_o h) \times 10^{-2}$,

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.3

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
1	0	0	0	0	0	0	0
	0.25	-998	-998	-997	-997	-996	-995
	0.50	-1195	-1195	-1194	-1194	-1192	-1190
	0.75	-692	-692	-692	-691	-690	-688
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	-624	-624	-624	-624	-623	-622
	0.50	-746	-746	-746	-745	-744	-742
	0.75	-431	-431	-430	-430	-429	-428
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	-641	-641	-641	-640	-640	-639
	0.50	-764	-764	-764	-763	-762	-760
	0.75	-440	-440	-439	-439	-438	-436
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	-397	-397	-396	-396	-396	-395
	0.50	-471	-471	-471	-470	-469	-468
	0.75	-270	-270	-270	-269	-268	-267
	1	0	0	0	0	0	0
				Outside Rings			
1	0	0	0	0	0	0	0
	0.25	-1407	-1407	-1408	-1408	-1409	-1410
	0.50	-1697	-1697	-1698	-1699	-1700	-1702
	0.75	-993	-993	-994	-994	-996	-997
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	-961	-961	-961	-962	-962	-963
	0.50	-1157	-1157	-1157	-1158	-1159	-1161
	0.75	-675	-675	-676	-676	-677	-678
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	-975	-976	-976	-976	-977	-978
	0.50	-1176	-1176	-1176	-1177	-1178	-1180
	0.75	-687	-687	-688	-688	-690	-691
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	-671	-671	-671	-672	-672	-673
	0.50	-807	-808	-808	-809	-810	-811
	0.75	-471	-471	-472	-472	-473	-474
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE A25

AXIAL MEMBRANE STRESSES, $-(\sigma_{xm}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, $b/a = 1.4$

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
1	0	-102	-103	-106	-109	-108	-98
	0.25	162	164	169	179	192	207
	0.50	404	405	409	415	421	427
	0.75	718	716	710	700	687	672
	1	1054	1052	1047	1038	1025	1004
2	0	11	10	8	6	7	2
	0.25	205	207	212	220	230	243
	0.50	418	419	422	426	431	434
	0.75	674	672	668	660	649	637
	1	912	910	907	901	891	875
3	0	-56	-57	-60	-62	-60	-50
	0.25	154	156	161	170	182	196
	0.50	407	408	412	418	423	428
	0.75	726	724	719	710	697	683
	1	1001	999	994	986	973	953
4	0	46	45	43	42	43	52
	0.25	201	202	207	214	224	236
	C.50	420	421	424	428	431	434
	0.75	679	677	673	665	655	644
	1	873	872	868	862	853	838
				Outside Rings			
1	0	801	801	800	797	790	774
	0.25	967	966	963	957	946	930
	0.50	475	474	469	464	457	452
	0.75	-87	-86	-83	-77	-66	-51
	1	8	11	20	34	54	80
2	0	765	765	765	762	756	742
	0.25	873	872	870	864	854	841
	0.50	458	457	454	450	445	442
	0.75	6	7	10	16	25	38
	1	77	80	86	97	112	132
3	0	826	826	826	824	817	802
	0.25	926	925	922	915	904	888
	0.50	468	467	463	458	452	447
	0.75	-47	-46	-42	-36	-24	-9
	1	-4	-1	7	20	38	62
4	0	783	783	783	782	776	762
	0.25	840	839	836	830	821	807
	0.50	454	453	450	446	442	439
	0.75	39	40	43	49	59	72
	1	68	70	76	85	99	118

*Case, see Table 1

TABLE A26

AXIAL BENDING STRESSES, $(\sigma_{xb}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, $b/a = 1.4$

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
1	0	1536	1405	929	-128	-2111	-5378
	0.25	1058	965	633	-86	-1410	-3559
	0.50	230	211	150	35	-150	-419
	0.75	-140	-108	-4	188	495	949
	1	-159	-112	27	260	583	997
2	0	1279	1174	793	-54	-1643	-4264
	0.25	884	809	542	-38	-1104	-2838
	0.50	224	204	141	22	-168	-443
	0.75	-21	-9	32	114	253	470
	1	-2	17	72	160	276	415
3	0	1593	1466	1002	-29	-1966	-5159
	0.25	1124	1030	697	-24	-1346	-3492
	0.50	286	261	179	24	-226	-589
	0.75	-133	-108	-29	121	365	729
	1	-185	-144	-24	176	454	810
4	0	1325	1222	847	115	-1558	-4146
	0.25	942	866	593	3	-1080	-2836
	0.50	285	259	174	14	-242	-613
	0.75	5	10	29	70	148	281
	1	-0.6	12	49	106	179	262
				Outside Rings			
1	0	-2591	-2438	-1876	-617	1762	5698
	0.25	-1793	-1675	-1256	-358	1280	3928
	0.50	115	108	88	56	13	-41
	0.75	1997	1806	1215	171	-1401	-3577
	1	2769	2485	1618	121	-2029	-4915
2	0	-2184	-2050	-1560	-464	1606	5029
	0.25	-1475	-1375	-1022	-264	1122	3366
	0.50	176	162	119	43	-74	-239
	0.75	1738	1567	1037	101	-1309	-3262
	1	2360	2110	1352	52	-1832	-4344
3	0	-2334	-2189	-1661	-480	1749	5435
	0.25	-1551	-1446	-1074	-272	1195	3574
	0.50	260	238	168	42	-152	-431
	0.75	1962	1767	1162	93	-1516	-3746
	1	2635	2355	1500	36	-2086	-4916
4	0	-1969	-1844	-1387	-366	1558	4740
	0.25	-1273	-1185	-875	-204	1027	3024
	0.50	302	275	190	32	-216	-575
	0.75	1730	1554	1009	48	-1400	-3407
	1	2277	2030	1277	-10	-1874	-4355

*Case, see Table 1

TABLE A27

CIRCUMFERENTIAL MEMBRANE STRESSES, $(\sigma_{sm}/q_o) \times 10$

FOR INSIDE AND OUTSIDE RINGS, $b/a = 1.4$

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
	0	51	206	650	1300	1976	2338
	0.25	-510	-413	-136	267	686	914
1	0.50	-753	-739	-699	-643	-586	-553
	0.75	-1533	-1547	-1587	-1647	-1713	-1765
	1	-2630	-2648	-2699	-2774	-2858	-2933
	0	-118	7	364	887	1431	1724
	0.25	-510	-432	-209	116	454	638
2	0.50	-775	-761	-723	-670	-616	-588
	0.75	-1428	-1435	-1455	-1486	-1523	-1556
	1	-2209	-2218	-2246	-2287	-2337	-2386
	0	-41	111	544	1179	1840	2193
	0.25	-438	-341	-65	338	756	984
3	0.50	-743	-726	-676	-606	-536	-497
	0.75	-1539	-1550	-1583	-1632	-1688	-1734
	1	-2426	-2442	-2488	-2555	-2631	-2700
	0	-180	-57	295	811	1348	1636
	0.25	-454	-375	-149	181	523	709
4	0.50	-757	-740	-691	-623	-556	-520
	0.75	-1417	-1421	-1434	-1455	-1482	-1511
	1	-2048	-2056	-2078	-2112	-2155	-2200
				Outside Rings			
	0	-625	-810	-1338	-2115	-2924	-3358
	0.25	-1589	-1710	-2053	-2553	-3071	-3352
1	0.50	-732	-732	-733	-734	-737	-745
	0.75	660	726	912	1174	1436	1584
	1	231	308	522	824	1129	1312
	0	-676	-837	-1298	-1975	-2680	-3061
	0.25	-1414	-1516	-1805	-2228	-2665	-2903
2	0.50	-729	-724	-710	-691	-674	-667
	0.75	383	443	608	842	1076	1206
	1	72	138	324	586	848	1002
	0	-700	-874	-1370	-2099	-2859	-3269
	0.25	-1446	-1554	-1861	-2309	-2774	-3029
3	0.50	-682	-673	-648	-614	-580	-569
	0.75	600	668	857	1124	1392	1541
	1	373	448	659	956	1254	1431
	0	-730	-880	-1309	-1939	-2597	-2953
	0.25	-1295	-1385	-1642	-2017	-2407	-2620
4	0.50	-683	-671	-635	-586	-537	-514
	0.75	345	406	576	815	1054	1186
	1	197	263	447	706	964	1114

*Case, see Table 1

TABLE A28

CIRCUMFERENTIAL BENDING STRESSES, $(\sigma_{sb}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, $b/a = 1.4$

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
	0	-428	-470	-620	-948	-1555	-2541
	0.25	-241	-270	-372	-592	-993	-1639
1	0.50	168	163	149	120	70	-7
	0.75	516	527	560	622	718	856
	1	643	657	699	768	865	989
	0	-182	-215	-336	-598	-1085	-1876
	0.25	-89	-113	-195	-372	-695	-1216
2	0.50	131	126	110	80	28	-52
	0.75	348	353	367	394	439	506
	1	438	443	459	485	519	560
	0	-103	-144	-290	-610	-1202	-2165
	0.25	-27	-56	-158	-378	-779	-1425
3	0.50	152	146	125	83	14	-92
	0.75	324	332	359	408	484	596
	1	393	405	442	502	585	692
	0	31	-2	-120	-379	-858	-1639
	0.25	52	29	-55	-235	-562	-1091
4	0.50	126	119	97	53	-19	-128
	0.75	232	234	242	257	283	324
	1	285	289	300	316	337	362
				Outside Rings			
	0	-2019	-1971	-1794	-1405	-679	508
	0.25	-1284	-1247	-1115	-838	-339	460
1	0.50	221	219	213	204	190	173
	0.75	1346	1286	1103	782	302	-354
	1	1700	1612	1343	886	227	-643
	0	-1519	-1476	-1322	-982	-350	683
	0.25	-952	-920	-809	-574	-152	525
2	0.50	197	192	179	156	119	68
	0.75	1030	977	813	526	96	-494
	1	1284	1207	972	573	-0.3	-758
	0	-1572	-1526	-1360	-994	-312	800
	0.25	-979	-946	-828	-580	-132	585
3	0.50	224	217	196	157	97	12
	0.75	1102	1042	855	526	36	-636
	1	1371	1284	1021	572	-74	-927
	0	-1201	-1161	-1017	-699	-110	850
	0.25	-735	-707	-609	-401	-25	578
4	0.50	202	194	168	119	42	-67
	0.75	872	817	649	354	-87	-692
	1	1071	994	762	368	-198	-946

*Case, see Table 1

TABLE A29

SHEAR MEMBRANE STRESSES, $(\tau_{xsm}/q_o) \times 10^2$,

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.4

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
		Inside Rings					
	0	0	0	0	0	0	0
	0.25	0	121	358	808	1519	2443
1	0.50	0	555	1194	1988	2973	4116
	0.75	0	664	1331	2004	2684	3378
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	126	343	729	132[illegible]	2084
2	0.50	0	455	975	1614	2402	3312
	0.75	0	517	1035	1554	2074	2601
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	127	363	802	1489	2378
3	0.50	0	530	1142	1905	2853	3955
	0.75	0	623	1252	1892	2545	3215
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	127	340	713	1284	2016
4	0.50	0	434	931	1546	2305	3185
	0.75	0	486	977	1473	1976	2488
	1	0	0	0	0	0	0
		Outside Rings					
	0	0	0	0	0	0	0
	0.25	0	-119	-389	-935	-1821	-2981
1	0.50	0	-551	-1237	-2166	-3390	-4853
	0.75	0	-661	-1360	-2128	-2973	-3882
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-104	-345	-834	-1630	-2674
2	0.50	0	-451	-1017	-1794	-2827	-4066
	0.75	0	-533	-1094	-1704	-2368	-3077
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-121	-392	-936	-1817	-2969
3	0.50	0	-541	-1209	-2106	-3283	-4686
	0.75	0	-644	-1318	-2043	-2826	-3658
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-105	-344	-828	-1612	-2640
4	0.50	0	-444	-997	-1749	-2741	-3928
	0.75	0	-522	-1066	-1646	-2264	-2914
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE A30

SHEAR BENDING STRESSES, $(\tau_{xsb}/q_o) \times 10^2$,

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.4

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
		Inside Rings					
	0	0	0	0	0	0	0
	0.25	0	-469	-867	-1077	-893	0
1	0.50	0	-395	-721	-877	-710	0
	0.75	0	-90	-152	-163	-111	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-368	-682	-847	-703	0
2	0.50	0	-288	-527	-644	-524	0
	0.75	0	-39	-63	-64	-39	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-434	-805	-1002	-833	0
3	0.50	0	-378	-690	-840	-682	0
	0.75	0	-100	-170	-186	-131	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-340	-632	-788	-656	0
4	0.50	0	-275	-505	-618	-505	0
	0.75	0	-49	-82	-87	-58	0
	1	0	0	0	0	0	0
		Outside Rings					
	0	0	0	0	0	0	0
	0.25	0	558	1035	1291	1075	0
1	0.50	0	828	1490	1777	1405	0
	0.75	0	614	1072	1222	912	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	514	952	1185	984	0
2	0.50	0	723	1299	1549	1224	0
	0.75	0	508	885	1005	747	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	574	1062	1320	1094	0
3	0.50	0	797	1433	1706	1347	0
	0.75	0	553	964	1093	811	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	523	967	1198	991	0
4	0.50	0	695	1249	1487	1173	0
	0.75	0	460	800	904	668	0
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE A31

RADIAL DEFORMATIONS, $(Ew/q_o h) \times 10^{-2}$,

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.4

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
		Inside Rings					
	0	-2518	-2527	-2554	-2593	-2634	-2654
	0.25	-1442	-1449	-1467	-1494	-1521	-1534
1	0.50	1007	1006	1003	999	995	993
	0.75	3248	3250	3255	3261	3268	3271
	1	4116	4118	4123	4131	4138	4141
	0	-1576	-1584	-1605	-1637	-1669	-1685
	0.25	-892	-897	-912	-933	-955	-966
2	0.50	666	665	662	658	654	652
	0.75	2089	2090	2092	2095	2098	2099
	1	2640	2641	2643	2646	2648	2649
	0	-1619	-1628	-1654	-1693	-1732	-1752
	0.25	-915	-922	-940	-967	-994	-1007
3	0.50	684	683	679	674	668	666
	0.75	2144	2145	2149	2154	2159	2162
	1	2708	2710	2714	2721	2727	2730
	0	-999	-1006	-1028	-1059	-1090	-1106
	0.25	-555	-560	-575	-597	-619	-630
4	0.50	455	454	450	444	439	436
	0.75	1380	1381	1382	1383	1385	1386
	1	1739	1739	1740	1742	1744	1745
		Outside Rings					
	0	-3502	-3491	-3459	-3412	-3363	-3339
	0.25	-2007	-1999	-1976	-1944	-1910	-1893
1	0.50	1325	1324	1324	1323	1322	1321
	0.75	4265	4256	4231	4196	4163	4147
	1	5368	5356	5320	5272	5225	5203
	0	-2392	-2382	-2354	-2313	-2271	-2250
	0.25	-1355	-1348	-1329	-1301	-1272	-1258
2	0.50	935	935	933	930	928	927
	0.75	2923	2915	2893	2862	2831	2817
	1	3658	3647	3616	3574	3533	3514
	0	-2424	-2413	-2383	-2339	-2294	-2271
	0.25	-1376	-1369	-1349	-1319	-1289	-1274
3	0.50	936	935	932	928	924	922
	0.75	2942	2933	2907	2871	2837	2821
	1	3683	3670	3636	3588	3542	3520
	0	-1663	-1654	-1628	-1590	-1551	-1531
	0.25	-932	-926	-909	-884	-859	-847
4	0.50	668	667	663	658	652	650
	0.75	2033	2025	2002	1970	1939	1924
	1	2530	2519	2489	2446	2406	2387

*Case, see Table 1

TABLE A32

CIRCUMFERENTIAL DEFORMATIONS, $(Ev/q_o h) \times 10^{-2}$

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.4

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
		Inside Rings					
	0	0	0	0	0	0	0
	0.25	-1232	-1232	-1232	-1232	-1231	-1230
1	0.50	-1407	-1407	-1406	-1405	-1404	-1401
	0.75	-758	-758	-757	-756	-754	-752
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-774	-774	-774	-774	-773	-772
2	0.50	-880	-880	-880	-879	-878	-876
	0.75	-471	-471	-470	-470	-468	-467
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-793	-793	-792	-792	-791	-790
3	0.50	-899	-899	-899	-898	-896	-894
	0.75	-479	-479	-478	-477	-476	-474
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-492	-492	-492	-492	-491	-490
4	0.50	-556	-555	-555	-554	-553	-551
	0.75	-294	-293	-293	-292	-291	-290
	1	0	0	0	0	0	0
		Outside Rings					
	0	0	0	0	0	0	0
	0.25	-1732	-1732	-1733	-1733	-1734	-1736
1	0.50	-2001	-2001	-2002	-2003	-2004	-2007
	0.75	-1097	-1097	-1098	-1099	-1101	-1103
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-1188	-1188	-1188	-1188	-1189	-1190
2	0.50	-1368	-1368	-1369	-1370	-1371	-1373
	0.75	-747	-747	-748	-749	-750	-752
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-1204	-1204	-1204	-1205	-1206	-1207
3	0.50	-1390	-1390	-1390	-1391	-1393	-1396
	0.75	-761	-761	-762	-763	-764	-766
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-831	-832	-832	-832	-833	-834
4	0.50	-957	-958	-958	-959	-960	-962
	0.75	-522	-523	-523	-524	-525	-527
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE A33

AXIAL MEMBRANE STRESSES, $-(\sigma_{xm}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.5

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
		Inside Rings					
1	0	-204	-207	-214	-221	-225	-218
	0.25	121	124	131	144	162	180
	0.50	371	373	379	388	397	407
	0.75	743	740	732	719	702	683
	1	1190	1188	1183	1173	1158	1132
2	0	-76	-78	-83	-88	-91	-83
	0.25	168	170	177	188	202	218
	0.50	396	397	401	407	414	419
	0.75	696	694	687	676	662	646
	1	1012	1011	1007	1001	991	972
3	0	-147	-149	-155	-161	-164	-156
	0.25	108	110	117	129	145	163
	0.50	377	379	384	392	401	409
	0.75	756	754	747	735	718	701
	1	1120	1119	1113	1104	1089	1064
4	0	-31	-32	-37	-41	-43	-35
	0.25	159	161	167	177	190	205
	0.50	399	400	404	410	416	421
	0.75	705	703	697	687	673	659
	1	960	959	956	949	939	921
		Outside Rings					
1	0	790	790	788	785	777	762
	0.25	1079	1079	1076	1070	1058	1040
	0.50	494	491	486	477	468	458
	0.75	-216	-215	-212	-206	-195	-176
	1	-50	-46	-33	-12	15	49
2	0	761	761	760	758	751	736
	0.25	967	967	964	958	947	932
	0.50	467	465	461	454	448	442
	0.75	-104	-103	-100	-94	-83	-68
	1	33	36	46	61	81	106
3	0	829	829	829	827	820	805
	0.25	1029	1028	1025	1017	1005	987
	0.50	482	480	475	467	458	451
	0.75	-166	-165	-161	-154	-141	-123
	1	-67	-63	-52	-34	-10	21
4	0	791	791	792	790	785	771
	0.25	926	925	921	914	903	888
	0.50	459	458	454	448	442	437
	0.75	-62	-61	-58	-51	-39	-24
	1	17	20	28	42	59	82

*Case, see Table 1

TABLE A34

AXIAL BENDING STRESSES, $(\sigma_{xb}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.5

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
		Inside Rings					
1	0	1779	1640	1114	-104	-2464	-6437
	0.25	1196	1099	739	-72	-1615	-4177
	0.50	248	229	164	42	-156	-441
	0.75	-48	-24	56	210	468	862
	1	20	53	148	296	481	689
2	0	1493	1380	956	-27	-1933	-5142
	0.25	1002	924	634	-21	-1268	-3339
	0.50	236	216	150	27	-169	-450
	0.75	62	66	83	126	214	370
	1	164	168	178	181	162	104
3	0	1818	1684	1179	7	-2269	-6101
	0.25	1253	1156	800	-2	-1523	-4045
	0.50	303	277	191	29	-232	-611
	0.75	-64	-46	15	134	339	658
	1	-45	-16	69	200	365	550
4	0	1520	1411	1000	46	-1806	-4928
	0.25	1051	972	680	24	-1220	-3285
	0.50	295	268	181	17	-244	-621
	0.75	71	69	67	76	113	198
	1	134	134	133	120	80	-2
		Outside Rings					
1	0	-2896	-2742	-2154	-766	1957	6573
	0.25	-2081	-1951	-1482	-443	1500	4696
	0.50	-14	-8	14	65	161	318
	0.75	2195	1984	1331	190	-1510	-3844
	1	3152	2822	1824	130	-2299	-5504
2	0	-2460	-2324	-1806	-586	1805	5853
	0.25	-1716	-1607	-1211	-332	1318	4037
	0.50	93	88	73	52	28	1
	0.75	1921	1730	1141	111	-1426	-3539
	1	2683	2394	1521	40	-2077	-4860
3	0	-2633	-2486	-1925	-607	1973	6341
	0.25	-1810	-1694	-1275	-343	1409	4301
	0.50	174	160	119	51	-47	-180
	0.75	2150	1934	1268	102	-1639	-4029
	1	2967	2646	1672	22	-2337	-5440
4	0	-2242	-2114	-1623	-472	1779	5586
	0.25	-1491	-1395	-1045	-262	1215	3658
	0.50	254	232	164	40	-151	-424
	0.75	1904	1709	1106	50	-1526	-3692
	1	2559	2276	1419	-30	-2098	-4809

*Case, see Table 1

TABLE A35

CIRCUMFERENTIAL MEMBRANE STRESSES, $(\sigma_{sm}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.5

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
	0	149	340	888	1696	2541	2991
	0.25	-545	-429	-99	387	895	1173
1	0.50	-701	-684	-638	-573	-505	-462
	0.75	-1640	-1652	-1684	-1732	-1789	-1840
	1	-3118	-3133	-3176	-3241	-3320	-3400
	0	-34	121	564	1219	1905	2273
	0.25	-526	-433	-166	226	637	862
2	0.50	-740	-725	-683	-623	-563	-529
	0.75	-1519	-1523	-1537	-1559	-1588	-1622
	1	-2576	-2583	-2604	-2637	-2682	-2735
	0	26	210	738	1517	2332	2767
	0.25	-454	-339	-13	466	966	1240
3	0.50	-706	-687	-631	-553	-473	-425
	0.75	-1672	-1682	-1708	-1749	-1798	-1844
	1	-2865	-2878	-2918	-2977	-3050	-3126
	0	-124	26	457	1093	1760	2118
	0.25	-454	-361	-94	298	707	931
4	0.50	-735	-716	-664	-590	-517	-476
	0.75	-1530	-1532	-1540	-1555	-1577	-1606
	1	-2374	-2380	-2398	-2427	-2467	-2516
				Outside Rings			
	0	-337	-554	-1180	-2106	-3078	-3600
	0.25	-1766	-1914	-2334	-2950	-3590	-3939
1	0.50	-701	-711	-737	-776	-818	-850
	0.75	1112	1177	1360	1619	1878	2029
	1	430	503	707	996	1291	1480
	0	-432	-623	-1174	-1989	-2846	-3308
	0.25	-1557	-1682	-2038	-2559	-3102	-3397
2	0.50	-691	-692	-697	-703	-711	-721
	0.75	766	825	989	1221	1454	1587
	1	230	294	470	719	972	1128
	0	-452	-658	-1253	-2132	-3056	-3554
	0.25	-1594	-1726	-2105	-2660	-3238	-3555
3	0.50	-646	-644	-638	-631	-626	-633
	0.75	1025	1092	1279	1542	1806	1957
	1	607	678	877	1158	1444	1624
	0	-523	-704	-1223	-1992	-2801	-3239
	0.25	-1412	-1523	-1841	-2307	-2794	-3061
4	0.50	-643	-634	-611	-578	-546	-535
	0.75	703	763	931	1168	1405	1539
	1	391	453	625	869	1114	1265

*Case, see Table 1

TABLE A36

CIRCUMFERENTIAL BENDING STRESSES, $(\sigma_{sb}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.5

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
	0	-497	-542	-709	-1088	-1811	-3011
	0.25	-289	-319	-430	-678	-1145	-1915
1	0.50	190	186	172	143	92	10
	0.75	633	642	668	719	800	921
	1	806	816	844	886	940	1000
	0	-212	-249	-384	-690	-1273	-2242
	0.25	-112	-137	-226	-425	-803	-1426
2	0.50	147	143	128	97	46	-35
	0.75	432	434	441	457	486	535
	1	557	558	559	558	549	530
	0	-131	-174	-334	-698	-1394	-2551
	0.25	-47	-77	-187	-431	-892	-1650
3	0.50	169	163	142	100	29	-81
	0.75	404	410	431	471	536	634
	1	506	515	539	578	626	680
	0	27	-8	-138	-434	-1001	-1943
	0.25	47	22	-67	-267	-644	-1264
4	0.50	138	131	109	66	-6	-116
	0.75	290	290	291	297	311	338
	1	371	371	369	363	349	324
				Outside Rings			
	0	-2306	-2258	-2074	-1646	-817	575
	0.25	-1484	-1443	-1296	-975	-383	580
1	0.50	218	220	228	245	274	321
	0.75	1518	1453	1251	899	380	-324
	1	1940	1837	1527	1005	263	-705
	0	-1745	-1702	-1539	-1162	-432	788
	0.25	-1102	-1068	-943	-672	-169	651
2	0.50	204	203	199	192	184	175
	0.75	1164	1104	922	605	136	-502
	1	1460	1370	1100	644	-1	-841
	0	-1805	-1758	-1581	-1174	-386	932
	0.25	-1135	-1098	-967	-678	-144	728
3	0.50	230	226	214	193	162	122
	0.75	1237	1170	964	606	75	-646
	1	1550	1450	1149	642	-76	-1012
	0	-1388	-1347	-1192	-834	-146	1002
	0.25	-855	-824	-714	-471	-20	716
4	0.50	216	209	188	149	90	7
	0.75	979	918	732	408	-73	-726
	1	1205	1117	853	408	-221	-1038

*Case, see Table 1

TABLE A37

SHEAR MEMBRANE STRESSES, $(\tau_{xsm}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.5

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
1	0	0	0	0	0	0	0
	0.25	0	6	26	73	153	259
	0.50	0	65	139	232	348	482
	0.75	0	86	171	255	339	422
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	0	9	29	71	139	228
	0.50	0	53	114	188	281	388
	0.75	0	66	131	196	258	321
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	0	80	29	75	152	254
	0.50	0	62	134	223	334	463
	0.75	0	8	160	240	320	401
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	0	10	30	71	136	222
	0.50	0	51	109	181	270	374
	0.75	0	62	123	185	245	306
	1	0	0	0	0	0	0
				Outside Rings			
1	0	0	0	0	0	0	0
	0.25	0	-8	-34	-92	-189	-318
	0.50	0	-66	-147	-256	-398	-568
	0.75	0	-85	-173	-269	-374	-485
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	0	-8	-32	-86	-175	-294
	0.50	0	-54	-121	-212	-332	-476
	0.75	0	-68	-139	-214	-295	-380
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	0	-9	-36	-94	-192	-322
	0.50	0	-65	-144	-249	-386	-549
	0.75	0	-82	-168	-258	-354	-454
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	0	-9	-33	-86	-176	-295
	0.50	0	-53	-119	-207	-323	-461
	0.75	0	-67	-135	-206	-281	-358
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE A38

SHEAR BENDING STRESSES, $(\tau_{xsb}/q_o) \times 10^2$ AND $(\tau_{xsb}/q_o) \times 10$,

FOR INSIDE AND OUTSIDE RINGS, RESPECTIVELY, b/a = 1.5

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				Inside Rings			
1	0	0	0	0	0	0	0
	0.25	0	-562	-1045	-1308	-1093	0
	0.50	0	-423	-776	-954	-782	0
	0.75	0	-36	-53	-42	-12	0
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	0	-449	-835	-1046	-875	0
	0.50	0	-307	-567	-701	-579	0
	0.75	0	14	34	54	57	0
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	0	-516	-961	-1206	-1011	0
	0.50	0	-404	-742	-913	-749	0
	0.75	0	-56	-89	-86	-48	0
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	0	-411	-767	-963	-809	0
	0.50	0	-293	-542	-672	-556	0
	0.75	0	-4	.1	13	23	0
	1	0	0	0	0	0	0
				Outside Rings			
1	0	0	0	0	0	0	0
	0.25	0	56	106	135	114	0
	0.50	0	93	168	201	159	0
	0.75	0	75	131	149	111	0
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	0	54	100	127	107	0
	0.50	0	82	147	176	139	0
	0.75	0	62	108	122	90	0
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	0	60	113	142	119	0
	0.50	0	90	162	193	153	0
	0.75	0	66	116	131	97	0
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	0	56	105	132	110	0
	0.50	0	78	141	169	134	0
	0.75	0	55	95	107	78	0
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE A39

RADIAL DEFORMATIONS, $(Ew/q_o h) \times 10^{-3}$

FOR INSIDE AND OUTSIDE RINGS, b/a = 1.5

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
		Inside Rings					
	0	-274	-275	-278	-283	-288	-290
	0.25	-149	-150	-152	-155	-158	-160
1	0.50	135	135	134	134	134	133
	0.75	395	395	395	396	396	397
	1	495	496	496	496	497	497
	0	-173	-174	-176	-180	-184	-186
	0.25	-93	-93	-95	-97	-100	-101
2	0.50	89	89	88	88	88	87
	0.75	254	254	254	255	255	255
	1	318	318	318	318	318	318
	0	-176	-178	-181	-185	-190	-192
	0.25	-95	-95	-98	-100	-104	-105
3	0.50	91	91	91	90	89	89
	0.75	261	261	261	261	262	262
	1	326	326	326	327	327	327
	0	-110	-110	-113	-116	-120	-122
	0.25	-58	-58	-60	-62	-65	-66
4	0.50	60	60	60	59	59	58
	0.75	168	168	168	168	168	168
	1	210	210	210	209	209	209
		Outside Rings					
	0	-381	-380	-376	-371	-366	-363
	0.25	-208	-207	-205	-201	-197	-195
1	0.50	176	176	176	177	177	177
	0.75	514	513	511	507	503	502
	1	640	639	635	630	624	622
	0	-262	-261	-258	-253	-248	-246
	0.25	-141	-140	-138	-135	-131	-130
2	0.50	124	124	124	124	124	124
	0.75	353	352	349	346	343	341
	1	436	435	432	427	422	420
	0	-265	-264	-260	-255	-250	-248
	0.25	-143	-142	-140	-137	-133	-131
3	0.50	124	124	124	124	124	124
	0.75	354	354	351	347	343	341
	1	439	438	434	428	423	421
	0	-183	-182	-179	-175	-170	-168
	0.25	-98	-97	-95	-92	-89	-87
4	0.50	88	88	88	88	87	87
	0.75	245	244	242	238	235	233
	1	301	300	297	292	287	285

*Case, see Table 1

TABLE A40

CIRCUMFERENTIAL DEFORMATIONS, $(Ev/q_o h) \times 10^{-2}$ AND $(Ev/q_o h) \times 10^{-3}$,

FOR INSIDE AND OUTSIDE RINGS, RESPECTIVELY, b/a = 1.5

*	$4s/L_o$	2x/L 0	0.2	0.4	0.6	0.8	1.0
		Inside Rings					
	0	0	0	0	0	0	0
	0.25	-1406	-1406	-1406	-1406	-1405	-1404
1	0.50	-1531	-1531	-1530	-1529	-1527	-1525
	0.75	-759	-759	-758	-757	-755	-753
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-887	-887	-887	-887	-886	-885
2	0.50	-961	-960	-960	-959	-958	-955
	0.75	-472	-471	-471	-470	-468	-466
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-906	-906	-905	-905	-904	-903
3	0.50	-978	-977	-977	-976	-974	-971
	0.75	-477	-477	-476	-475	-473	-471
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-564	-564	-564	-564	-563	-562
4	0.50	-605	-605	-604	-604	-602	-600
	0.75	-291	-291	-290	-290	-288	-286
	1	0	0	0	0	0	0
		Outside Rings					
	0	0	0	0	0	0	0
	0.25	-197	-197	-197	-197	-197	-198
1	0.50	-218	-218	-218	-218	-219	-219
	0.75	-112	-112	-112	-112	-112	-112
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-136	-136	-136	-136	-136	-136
2	0.50	-150	-150	-150	-150	-150	-150
	0.75	-76	-76	-76	-76	-76	-77
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-137	-137	-137	-138	-138	-138
3	0.50	-152	-152	-152	-152	-152	-153
	0.75	-78	-78	-78	-78	-78	-78
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-95	-95	-95	-95	-95	-96
4	0.50	-105	-105	-105	-105	-106	-106
	0.75	-53	-53	-54	-54	-54	-54
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE B1

AXIAL MEMBRANE AND BENDING STRESSES,

$-(\sigma_{xm}/q_o) \times 10$ AND $(\sigma_{xb}/q_o) \times 10$, FOR MEDIAN LINE RINGS, b/a = 1.1

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				$-(\sigma_{xm}/q_o) \times 10$			
1	0	438	438	438	438	438	438
	0.25	467	467	467	467	468	468
	0.50	456	456	456	456	456	456
	0.75	447	447	446	446	446	446
	1	477	477	477	477	476	476
2	0	441	441	441	441	441	442
	0.25	464	464	464	464	464	465
	0.50	457	457	457	457	457	457
	0.75	450	450	449	449	449	449
	1	472	472	472	472	472	472
3	0	442	443	443	443	443	443
	0.25	462	462	462	462	463	463
	0.50	457	457	457	457	457	457
	0.75	452	451	451	451	451	451
	1	470	470	470	470	470	470
4	0	445	445	446	446	446	446
	0.25	460	460	460	460	460	461
	0.50	457	457	457	457	457	457
	0.75	454	454	453	453	453	453
	1	468	468	468	467	467	467
				$(\sigma_{xb}/q_o) \times 10$			
1	0	-343	-350	-375	-424	-505	-627
	0.25	-178	-188	-221	-285	-389	-546
	0.50	203	185	128	20	-153	-404
	0.75	563	534	445	281	24	-342
	1	705	672	566	376	80	-339
2	0	-224	-232	-256	-304	-384	-504
	0.25	-98	-108	-141	-204	-307	-461
	0.50	198	180	122	15	-157	-408
	0.75	484	455	365	200	-59	-428
	1	599	565	459	266	-33	-457
3	0	-89	-104	-153	-249	-409	-650
	0.25	19	1	-56	-167	-349	-621
	0.50	274	248	166	12	-235	-595
	0.75	521	485	371	162	-164	-631
	1	622	580	451	216	-148	-664
4	0	-18	-33	-82	-176	-334	-572
	0.25	67	50	-8	-118	-299	-570
	0.50	272	246	163	8	-240	-601
	0.75	474	437	323	113	-215	-683
	1	557	515	386	150	-214	-732

*Case, see Table 1

TABLE B2

CIRCUMFERENTIAL MEMBRANE AND BENDING STRESSES,

$(\sigma_{sm}/q_o) \times 10$ AND $(\sigma_{sb}/q_o) \times 10$, FOR MEDIAN LINE RINGS, b/a = 1.1

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				$(\sigma_{sm}/q_o) \times 10$			
1	0	-726	-720	-705	-684	-662	-652
	0.25	-833	-826	-807	-780	-753	-740
	0.50	-818	-808	-779	-738	-698	-679
	0.75	-806	-792	-753	-699	-646	-621
	1	-916	-900	-858	-798	-740	-712
2	0	-736	-731	-716	-695	-673	-663
	0.25	-822	-815	-796	-770	-744	-731
	0.50	-820	-809	-781	-740	-701	-682
	0.75	-816	-802	-763	-709	-655	-630
	1	-901	-886	-842	-782	-722	-694
3	0	-708	-698	-668	-625	-583	-562
	0.25	-780	-768	-736	-689	-643	-620
	0.50	-780	-765	-724	-666	-610	-582
	0.75	-779	-761	-711	-642	-574	-542
	1	-850	-831	-778	-704	-632	-598
4	0	-716	-706	-677	-635	-593	-573
	0.25	-772	-761	-728	-682	-636	-614
	0.50	-780	-766	-724	-666	-610	-582
	0.75	-786	-768	-719	-649	-581	-549
	1	-840	-821	-768	-694	-622	-588
				$(\sigma_{sb}/q_o) \times 10$			
1	0	-1394	-1396	-1403	-1417	-1441	-1478
	0.25	-922	-924	-934	-953	-984	-1030
	0.50	124	119	102	70	18	-58
	0.75	1037	1028	1001	952	874	764
	1	1376	1366	1334	1276	1186	1060
2	0	-995	-997	-1004	-1018	-1042	-1077
	0.25	-652	-654	-664	-682	-713	-759
	0.50	107	102	85	53	1	-74
	0.75	767	758	731	681	603	492
	1	1011	1001	969	510	820	692
3	0	-792	-796	-811	-839	-887	-959
	0.25	-507	-512	-529	-562	-617	-698
	0.50	122	114	90	44	-30	-138
	0.75	669	658	624	561	463	322
	1	872	860	820	749	639	484
4	0	-550	-554	-568	-596	-643	-714
	0.25	-344	-349	-366	-399	-453	-534
	0.50	111	103	78	32	-42	-151
	0.75	506	495	461	397	299	158
	1	653	640	601	530	420	264

*Case, see Table 1

TABLE B3

SHEAR MEMBRANE AND BENDING STRESSES,

$(\tau_{xsm}/q_o)\ 10^3$ AND $(\tau_{xsb}/q_o) \times 10^3$, FOR MEDIAN LINE RINGS, b/a = 1.1

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				$(\tau_{xsm}/q_o) \times 10^3$			
1	0	0	0	0	0	0	0
	0.25	0	119	203	226	177	73
	0.50	0	190	330	381	330	203
	0.75	0	150	263	313	290	214
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	0	143	252	300	278	203
	0.50	0	196	341	394	343	213
	0.75	0	134	230	258	207	98
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	0	129	230	281	274	227
	0.50	0	175	308	366	342	256
	0.75	0	118	205	237	209	135
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	0	137	244	297	290	239
	0.50	0	179	315	375	350	262
	0.75	0	116	201	233	204	132
	1	0	0	0	0	0	0
				$(\tau_{xsb}/q_o) \times 10^3$			
1	0	0	0	0	0	0	0
	0.25	0	229	408	481	374	0
	0.50	0	420	745	868	668	0
	0.75	0	366	646	748	570	0
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	0	299	408	480	374	0
	0.50	0	430	762	888	683	0
	0.75	0	379	669	775	592	0
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	0	224	397	462	354	0
	0.50	0	410	722	836	636	0
	0.75	0	355	625	720	546	0
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	0	235	416	485	373	0
	0.50	0	415	733	848	646	0
	0.75	0	353	620	714	541	0
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE B4

RADIAL AND CIRCUMFERENTIAL DEFORMATIONS,

$(Ew/q_o h) \times 10^{-3}$ AND $(Ev/q_o h) \times 10^{-3}$, FOR MEDIAN LINE RINGS, b/a = 1.1

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
					$(Ew/q_o h) \times 10^{-3}$		
1	0	-480	-480	-480	-480	-480	-480
	0.25	-322	-322	-322	-322	-322	-322
	0.50	50	50	49	49	49	48
	0.75	408	408	407	407	406	406
	1	552	552	552	551	550	550
2	0	-342	-342	-342	-342	-342	-343
	0.25	-229	-229	-229	-229	-229	-230
	0.50	38	38	37	37	36	36
	0.75	294	294	293	293	292	292
	1	397	397	397	396	395	395
3	0	-281	-282	-282	-282	-282	-283
	0.25	-188	-188	-188	-189	-189	-189
	0.50	32	32	31	31	33	30
	0.75	243	243	242	242	241	241
	1	328	328	328	327	326	326
4	0	-198	-198	-198	-199	-199	-199
	0.25	-132	-132	-132	-132	-133	-133
	0.50	24	24	24	23	23	22
	0.75	174	174	174	173	172	172
	1	235	234	234	233	232	232
					$(Ev/q_o h) \times 10^{-3}$		
1	0	0	0	0	0	0	0
	0.25	-191	-191	-191	-191	-191	-191
	0.50	-255	-255	-255	-255	-255	-255
	0.75	-169	-169	-169	-169	-169	-169
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	-137	-137	-137	-137	-137	-137
	0.50	-182	-182	-182	-182	-182	-182
	0.75	-121	-121	-121	-121	-121	-121
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	-113	-113	-113	-113	-113	-113
	0.50	-150	-150	-150	-150	-150	-150
	0.75	-100	-100	-100	-100	-100	-100
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	-80	-80	-80	-80	-80	-80
	0.50	-107	-107	-107	-107	-107	-107
	0.75	-71	-71	-71	-71	-71	-71
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE B5

AXIAL MEMBRANE AND BENDING STRESSES,

$-(\sigma_{xm}/q_o) \times 10$ AND $(\sigma_{xb}/q_o) \times 10$, FOR MEDIAN LINE RINGS, b/a = 1.2

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
		$-(\sigma_{xm}/q_o) \times 10$					
1	0	360	359	359	358	358	358
	0.25	512	512	512	513	514	514
	0.50	453	453	453	453	453	453
	0.75	394	393	393	392	392	391
	1	546	546	546	546	546	546
2	0	377	368	376	376	376	376
	0.25	499	493	500	500	501	501
	0.50	453	453	453	453	453	453
	0.75	406	412	406	405	404	404
	1	528	536	528	528	528	528
3	0	388	387	387	387	387	387
	0.25	490	491	491	492	492	492
	0.50	453	453	453	453	453	453
	0.75	415	415	414	414	413	413
	1	517	517	518	518	518	518
4	0	401	401	401	401	401	401
	0.25	481	481	481	482	482	483
	0.50	453	453	453	453	453	453
	0.75	425	425	424	424	423	423
	1	503	503	503	504	504	504
		$(\sigma_{xb}/q_o) \times 10$					
1	0	-760	-764	-781	-814	-870	-956
	0.25	-481	-486	-502	-534	-590	-677
	0.50	206	192	144	56	-84	-288
	0.75	916	876	750	524	180	-303
	1	1216	1161	988	682	218	-427
2	0	-546	-550	-563	-588	-632	-698
	0.25	-332	-336	-351	-382	-436	-518
	0.50	205	189	139	44	-105	-323
	0.75	768	728	600	372	24	-464
	1	1009	954	783	479	18	-622
3	0	-366	-377	-412	-482	-604	-792
	0.25	-182	-194	-233	-313	-448	-655
	0.50	281	257	180	37	-192	-526
	0.75	769	721	571	303	-108	-682
	1	978	916	726	388	-122	-831
4	0	-236	-246	-278	-343	-456	-632
	0.25	-91	-103	-142	-221	-355	-560
	0.50	280	255	176	28	-209	-553
	0.75	679	631	481	211	-202	-780
	1	853	792	603	267	-240	-943

*Case, see Table 1

TABLE B6

CIRCUMFERENTIAL MEMBRANE AND BENDING STRESSES,

$(\sigma_{sm}/q_o) \times 10$ AND (σ_{sb}/q_o), FOR MEDIAN LINE RINGS, b/a = 1.2

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
		$(\sigma_{sm}/q_o) \times 10$					
1	0	-457	-453	-441	-424	-407	-399
	0.25	-969	-965	-954	-939	-923	-915
	0.50	-797	-789	-765	-732	-699	-683
	0.75	-647	-630	-583	-516	-452	-422
	1	-1181	-1160	-1103	-1023	-945	-908
2	0	-510	-504	-497	-484	-470	-464
	0.25	-925	-919	-911	-896	-881	-873
	0.50	-801	-792	-767	-731	-696	-680
	0.75	-691	-675	-626	-558	-493	-462
	1	-1119	-1101	-1042	-962	-885	-848
3	0	-515	-506	-481	-446	-410	-392
	0.25	-865	-856	-830	-793	-756	-737
	0.50	-764	-750	-712	-658	-604	-579
	0.75	-673	-653	-596	-517	-440	-404
	1	-1033	-1010	-947	-858	-772	-732
4	0	-556	-548	-525	-492	-458	-441
	0.25	-831	-822	-796	-759	-723	-704
	0.50	-767	-753	-713	-658	-603	-577
	0.75	-706	-686	-629	-550	-472	-436
	1	-985	-963	-899	-811	-726	-686
		(σ_{sb}/q_o)					
1	0	-270	-270	-271	-272	-274	-276
	0.25	-177	-177	-178	-179	-180	-183
	0.50	23	23	22	19	15	9
	0.75	190	189	185	178	168	154
	1	250	248	242	233	219	199
2	0	-195	-195	-196	-196	-198	-200
	0.25	-127	-127	-127	-128	-130	-132
	0.50	20	19	18	15	11	4
	0.75	140	139	135	128	117	[illegible]
	1	182	180	175	165	151	132
3	0	-159	-159	-160	-162	-166	-171
	0.25	-102	-102	-103	-106	-110	-116
	0.50	20	19	17	13	6	-4
	0.75	119	118	113	105	93	76
	1	154	152	146	136	120	99
4	0	-113	-113	-114	-116	-119	-124
	0.25	-71	-72	-73	-75	-79	-85
	0.50	17	16	14	10	3	-7
	0.75	89	87	83	75	62	45
	1	114	112	106	96	80	59

*Case, see Table 1

TABLE B7

SHEAR MEMBRANE AND BENDING STRESSES,

$(\tau_{xsm}/q_o) \times 10^3$ AND $(\tau_{xsb}/q_o) \times 10^3$, FOR MEDIAN LINE RINGS, b/a = 1.2

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				$(\tau_{xsm}/q_o) \times 10^3$			
1	0	0	0	0	0	0	0
	0.25	0	133	243	311	331	318
	0.50	0	337	586	678	591	371
	0.75	0	344	585	648	505	208
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	0	182	328	410	419	374
	0.50	0	349	606	702	612	383
	0.75	0	312	530	583	446	168
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	0	168	305	387	407	383
	0.50	0	310	545	650	606	456
	0.75	0	270	466	532	450	261
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	0	206	372	467	482	440
	0.50	0	318	559	666	621	467
	0.75	0	243	418	475	396	220
	1	0	0	0	0	0	0
				$(\tau_{xsb}/q_o) \times 10^3$			
1	0	0	0	0	0	0	0
	0.25	0	94	168	199	156	0
	0.50	0	808	1429	1660	1272	0
	0.75	0	1048	1852	2149	1643	0
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	0	169	304	361	284	0
	0.50	0	824	1458	1696	1300	0
	0.75	0	996	1758	2037	1555	0
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	0	203	359	416	318	0
	0.50	0	786	1385	1599	1215	0
	0.75	0	909	1600	1845	1400	0
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	0	257	457	534	411	0
	0.50	0	795	1401	1619	1231	0
	0.75	0	868	1525	1756	1330	0
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE B8

RADIAL AND CIRCUMFERENTIAL DEFORMATIONS,

$(Ew/q_oh) \times 10^{-3}$ AND $(Ev/q_oh) \times 10^{-3}$, FOR MEDIAN LINE RINGS, b/a = 1.2

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				$(Ew/q_oh) \times 10^{-3}$			
1	0	-848	-848	-848	-848	-848	-848
	0.25	-546	-546	-546	-547	-547	-547
	0.50	156	156	156	155	155	155
	0.75	822	822	821	820	820	819
	1	1087	1087	1086	1085	1084	1084
2	0	-608	-608	-608	-608	-608	-608
	0.25	-390	-390	-390	-390	-390	-390
	0.50	115	115	115	114	114	114
	0.75	591	591	590	590	589	588
	1	780	780	779	778	777	776
3	0	-501	-501	-501	-501	-502	-502
	0.25	-321	-321	-321	-322	-322	-322
	0.50	96	96	95	95	94	94
	0.75	488	488	487	486	486	485
	1	644	644	643	642	640	640
4	0	-355	-355	-355	-355	-356	-356
	0.25	-226	-226	-227	-227	-227	-227
	0.50	70	70	70	69	69	69
	0.75	349	348	348	347	346	346
	1	458	458	457	456	455	455
				$(Ev/q_oh) \times 10^{-3}$			
1	0	0	0	0	0	0	0
	0.25	-367	-367	-367	-367	-367	-367
	0.50	-466	-466	-466	-466	-466	-466
	0.75	-292	-292	-292	-292	-292	-292
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	-263	-263	-263	-263	-263	-263
	0.50	-334	-334	-334	-334	-334	-334
	0.75	-209	-209	-209	-209	-209	-209
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	-217	-217	-217	-217	-217	-217
	0.50	-275	-275	-275	-275	-275	-275
	0.75	-172	-172	-172	-172	-172	-172
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	-154	-154	-154	-154	-154	-154
	0.50	-195	-195	-195	-195	-195	-195
	0.75	-122	-122	-122	-122	-122	-122
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE B9

AXIAL MEMBRANE AND BENDING STRESSES,

$-(\sigma_{xm}/q_o) \times 10$ AND $(\sigma_{xb}/q_o) \times 10$, FOR MEDIAN LINE RINGS, b/a = 1.3

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
		$-(\sigma_{xm}/q_o) \times 10$					
1	0	259	258	257	254	252	251
	0.25	572	572	573	575	577	578
	0.50	446	446	446	447	448	448
	0.75	322	322	320	318	316	315
	1	637	637	638	640	641	641
2	0	286	286	284	282	280	280
	0.25	551	552	553	555	557	558
	0.50	446	447	447	447	448	448
	0.75	342	342	341	339	337	336
	1	608	608	609	610	611	612
3	0	310	309	308	306	305	304
	0.25	534	534	535	537	538	539
	0.50	446	446	446	447	447	447
	0.75	360	359	358	357	355	354
	1	586	586	587	588	588	589
4	0	334	334	333	331	330	330
	0.25	515	516	517	519	520	521
	0.50	447	447	447	447	448	448
	0.75	378	378	376	375	374	373
	1	560	560	560	561	562	562
		$(\sigma_{xb}/q_o) \times 10$					
1	0	-1050	-1059	-1085	-1138	-1226	-1362
	0.25	-733	-733	-735	-743	-763	-798
	0.50	162	154	128	82	9	-91
	0.75	1236	1182	1016	725	290	-307
	1	1734	1650	1392	939	262	-567
2	0	-762	-768	-788	-828	-893	-993
	0.25	-524	-524	-526	-533	-550	-581
	0.50	170	160	128	69	-24	-155
	0.75	1031	977	809	514	74	-531
	1	1436	1354	1099	654	-11	-922
3	0	-555	-566	-603	-679	-812	-1021
	0.25	-347	-354	-380	-436	-536	-696
	0.50	255	235	173	58	-125	-389
	0.75	998	938	750	418	-78	-760
	1	1348	1261	995	529	-164	-1113
4	0	-381	-390	-422	-487	-602	-783
	0.25	-220	-227	-253	-308	-408	-565
	0.50	262	240	172	46	-154	-444
	0.75	873	812	624	291	-208	-895
	1	1165	1080	818	360	-320	-1250

*Case, see Table 1

TABLE B10

CIRCUMFERENTIAL MEMBRANE AND BENDING STRESSES,

$(\sigma_{sm}/q_o) \times 10$ AND (σ_{sb}/q_o), FOR MEDIAN LINE RINGS, b/a = 1.3

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
		$(\sigma_{sm}/q_o) \times 10$					
1	0	-132	-126	-106	-78	-49	-35
	0.25	-1161	-1160	-1157	-1152	-1146	-1143
	0.50	-756	-752	-738	-719	-701	-693
	0.75	-422	-402	-347	-270	-197	-162
	1	-1521	-1496	-1426	-1328	-1235	-1191
2	0	-215	-209	-194	-173	-152	-141
	0.25	-1091	-1090	-1087	-1083	-1078	-1075
	0.50	-764	-758	-742	-718	-696	-686
	0.75	-490	-470	-415	-338	-263	-228
	1	-1420	-1396	-1327	-1230	-1138	-1094
3	0	-262	-252	-223	-181	-139	-118
	0.25	-1006	-999	-979	-950	-922	-907
	0.50	-731	-720	-688	-644	-601	-580
	0.75	-501	-479	-416	-329	-245	-206
	1	-1289	-1263	-1190	-1089	-992	-947
4	0	-336	-327	-302	-266	-229	-210
	0.25	-944	-937	-917	-889	-860	-846
	0.50	-739	-726	-692	-645	-598	-576
	0.75	-562	-540	-477	-389	-305	-266
	1	-1199	-1173	-1101	-1002	-907	-862
		(σ_{sb}/q_o)					
1	0	-377	-377	-378	-380	-383	-387
	0.25	-249	-249	-249	-249	-249	-250
	0.50	30	30	29	28	26	23
	0.75	264	262	257	248	235	217
	1	348	345	337	323	302	274
2	0	-274	-274	-275	-276	-278	-282
	0.25	-179	-178	-178	-179	-179	-180
	0.50	26	26	25	24	21	17
	0.75	194	192	187	178	165	146
	1	252	250	242	228	208	180
3	0	-224	-225	-226	-228	-232	-239
	0.25	-145	-145	-146	-147	-150	-155
	0.50	25	25	23	20	15	7
	0.75	164	162	157	147	132	111
	1	213	210	201	187	166	138
4	0	-161	-161	-162	-164	-168	-173
	0.25	-102	-102	-103	-105	-108	-112
	0.50	22	22	20	16	10	2
	0.75	122	120	114	104	89	68
	1	156	153	145	131	110	82

*Case, see Table 1

TABLE B11

SHEAR MEMBRANE AND BENDING STRESSES,

$(\tau_{xsm}/q_o) \times 10^3$ AND $(\tau_{xsb}/q_o) \times 10^2$, FOR MEDIAN LINE RINGS, b/a = 1.3

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				$(\tau_{xsm}/q_o) \times 10^3$			
1	0	0	0	0	0	0	0
	0.25	0	-45	-56	-5	122	310
	0.50	0	429	745	865	760	490
	0.75	0	651	1110	1228	953	383
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	0	52	114	194	297	422
	0.50	0	446	775	899	788	505
	0.75	0	578	982	1077	817	292
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	0	58	118	187	269	366
	0.50	0	394	692	825	774	588
	0.75	0	499	860	980	825	466
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	0	144	272	371	442	496
	0.50	0	405	713	850	795	603
	0.75	0	429	736	830	682	356
	1	0	0	0	0	0	0
				$(\tau_{xsb}/q_o) \times 10^2$			
1	0	0	0	0	0	0	0
	0.25	0	-38	-68	-80	-63	0
	0.50	0	118	208	241	184	0
	0.75	0	205	362	421	322	0
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	0	-23	-40	-48	-37	0
	0.50	0	120	212	245	187	0
	0.75	0	192	340	394	302	0
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	0	-10	-19	-23	-19	0
	0.50	0	115	201	232	175	0
	0.75	0	172	304	351	267	0
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	0	2	4	4	2	0
	0.50	0	115	203	234	177	0
	0.75	0	161	283	327	248	0
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE B12

RADIAL AND CIRCUMFERENTIAL DEFORMATIONS,

$(Ew/q_oh) \times 10^{-3}$ AND $(Ev/q_oh) \times 10^{-3}$, FOR MEDIAN LINE RINGS, b/a = 1.3

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				$(Ew/q_oh) \times 10^{-3}$			
1	0	-1106	-1106	-1106	-1106	-1106	-1106
	0.25	-685	-685	-685	-685	-685	-685
	0.50	294	294	294	294	294	294
	0.75	1221	1221	1220	1219	1218	1218
	1	1590	1589	1588	1587	1585	1585
2	0	-796	-796	-796	-796	-796	-796
	0.25	-490	-490	-490	-490	-490	-490
	0.50	216	216	216	216	216	216
	0.75	879	878	878	877	876	875
	1	1140	1140	1138	1137	1136	1135
3	0	-656	-656	-656	-656	-657	-657
	0.25	-404	-404	-404	-404	-404	-404
	0.50	180	180	179	179	178	178
	0.75	725	725	724	723	722	722
	1	941	940	939	938	936	935
4	0	-467	-467	-467	-468	-468	-468
	0.25	-286	-286	-286	-286	-286	-286
	0.50	131	131	131	130	130	130
	0.75	518	518	517	516	515	514
	1	669	669	668	666	665	664
				$(Ev/q_oh) \times 10^{-3}$			
1	0	0	0	0	0	0	0
	0.25	-513	-513	-513	-513	-513	-513
	0.50	-624	-624	-624	-624	-624	-624
	0.75	-369	-369	-369	-369	-369	-369
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	-369	-369	-369	-369	-369	-369
	0.50	-448	-448	-448	-448	-448	-448
	0.75	-264	-264	-264	-264	-264	-264
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	-305	-305	-305	-305	-305	-305
	0.50	-369	-369	-369	-369	-369	-369
	0.75	-218	-218	-218	-218	-218	-218
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	-217	-217	-217	-217	-217	-217
	0.50	-263	-263	-263	-263	-263	-263
	0.75	-154	-154	-154	-154	-154	-154
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE B13

AXIAL MEMBRANE AND BENDING STRESSES,

$-(\sigma_{xm}/q_o) \times 10$ AND $(\sigma_{xb}/q_o) \times 10$, FOR MEDIAN LINE RINGS, b/a = 1.4

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
		$-(\sigma_{xm}/q_o) \times 10$					
	0	168	167	162	156	150	148
	0.25	624	625	628	632	636	638
1	0.50	437	437	438	439	440	441
	0.75	256	255	252	248	244	242
	1	717	718	721	724	728	729
	0	199	197	194	188	183	181
	0.25	601	602	604	608	612	614
2	0.50	438	438	439	440	441	441
	0.75	279	278	275	271	268	266
	1	684	685	687	691	694	696
	0	234	233	230	225	221	219
	0.25	575	576	579	582	585	587
3	0.50	437	437	438	439	440	440
	0.75	304	303	301	298	294	293
	1	651	652	654	656	659	660
	0	264	263	261	257	253	252
	0.25	553	553	556	558	561	563
4	0.50	438	439	439	440	440	440
	0.75	327	326	324	321	318	317
	1	618	618	620	623	625	626
		$(\sigma_{xb}/q_o) \times 10$					
	0	-1241	-1255	-1301	-1393	-1549	-1790
	0.25	-940	-936	-926	-913	-904	-902
1	0.50	82	82	85	94	112	149
	0.75	1521	1453	1245	886	361	-345
	1	2239	2123	1769	1152	239	-1003
	0	-893	-904	-942	-1017	-1143	-1336
	0.25	-681	-678	-668	-655	-644	-638
2	0.50	101	98	92	82	72	66
	0.75	1268	1200	990	627	96	-621
	1	1864	1751	1402	797	-97	-1312
	0	-671	-685	-734	-834	-1011	-1292
	0.25	-484	-487	-500	-535	-607	-732
3	0.50	199	186	144	69	-46	-208
	0.75	1207	1133	905	510	-72	-858
	1	1721	1606	1254	644	-254	-1471
	0	-464	-476	-517	-602	-753	-992
	0.25	-326	-329	-344	-379	-451	-574
4	0.50	216	200	150	58	-85	-288
	0.75	1053	979	750	353	-231	-1022
	1	1486	1374	1030	434	-442	-1626

*Case, see Table 1

TABLE B14

CIRCUMFERENTIAL MEMBRANE AND BENDING STRESSES,

$(\sigma_{sm}/q_o) \times 10$ AND (σ_{sb}/q_o), FOR MEDIAN LINE RINGS, b/a = 1.4

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
		$(\sigma_{sm}/q_o) \times 10$					
	0	146	159	196	248	301	327
	0.25	-1335	-1336	-1341	-1346	-1350	-1351
1	0.50	-705	-705	-705	-705	-707	-708
	0.75	-207	-185	-124	-40	41	78
	1	-1820	-1793	-1716	-1608	-1506	-1458
	0	57	67	97	140	184	205
	0.25	-1256	-1257	-1261	-1267	-1271	-1272
2	0.50	-716	-714	-710	-704	-700	-698
	0.75	-284	-262	-201	-116	-34	4
	1	-1705	-1678	-1602	-1496	-1395	-1348
	0	-28	-14	27	86	146	176
	0.25	-1146	-1141	-1128	-1108	-1086	-1075
3	0.50	-688	-680	-659	-629	-600	-586
	0.75	-322	-298	-231	-138	-49	-8
	1	-1532	-1504	-1427	-1320	-1218	-1170
	0	-119	-106	-72	-21	31	56
	0.25	-1068	-1063	-1049	-1029	-1008	-996
4	0.50	-700	-690	-665	-629	-595	-578
	0.75	-399	-375	-308	-214	-125	-84
	1	-1416	-1388	-1313	-1208	-1107	-1061
		(σ_{sb}/q_o)					
	0	-461	-461	-463	-466	-471	-478
	0.25	-307	-307	-307	-306	-306	-306
1	0.50	31	31	32	32	34	35
	0.75	325	323	316	306	290	268
	1	434	430	419	399	371	334
	0	-336	-336	-338	-340	-344	-350
	0.25	-221	-221	-221	-220	-220	-219
2	0.50	28	28	28	29	29	29
	0.75	239	237	230	219	203	182
	1	315	311	300	281	254	217
	0	-276	-276	-278	-281	-287	-295
	0.25	-180	-180	-180	-181	-183	-187
3	0.50	27	27	26	24	21	17
	0.75	202	200	192	180	163	139
	1	264	261	250	231	203	166
	0	-199	-199	-200	-203	-208	-215
	0.25	-128	-128	-128	-129	-131	-135
4	0.50	24	24	23	20	16	11
	0.75	150	147	140	128	111	87
	1	194	190	179	161	134	98

*Case, see Table 1

TABLE B15

SHEAR MEMBRANE AND BENDING STRESSES,

$(\tau_{xsm}/q_o) \times 10^3$ AND $(\tau_{xsb}/q_o) \times 10^2$, FOR MEDIAN LINE RINGS, b/a = 1.4

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
		$(\tau_{xsm}/q_o) \times 10^3$					
1	0	0	0	0	0	0	0
	0.25	0	-330	-538	-528	-252	230
	0.50	0	465	809	943	840	566
	0.75	0	987	1682	1862	1441	571
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	0	-195	-303	-253	-10	385
	0.50	0	486	846	985	874	581
	0.75	0	883	1500	1645	1246	437
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	C.25	0	-159	-255	-232	-62	225
	0.50	0	424	746	892	843	656
	0.75	0	759	1310	1494	1255	702
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	0	-26	-19	51	204	425
	0.50	0	440	773	924	870	672
	0.75	0	648	1112	1255	1027	525
	1	0	0	0	0	0	0
		$(\tau_{xsb}/q_o) \times 10^2$					
1	0	0	0	0	0	0	0
	0.25	0	-105	-188	-223	-176	0
	0.50	0	154	271	312	236	0
	0.75	0	323	572	665	510	0
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	0	-84	-151	-179	-140	0
	0.50	0	156	275	317	240	0
	0.75	0	305	540	627	480	0
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	0	-59	-107	-128	-102	0
	0.50	0	149	262	300	226	0
	0.75	0	271	477	553	422	0
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	0	-40	-73	-87	-69	0
	0.50	0	150	263	301	227	0
	0.75	0	252	444	513	390	0
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE B16

RADIAL AND CIRCUMFERENTIAL DEFORMATIONS,

$(Ew/q_oh) \times 10^{-3}$ AND $(Ev/q_oh) \times 10^{-3}$, FOR MEDIAN LINE RINGS, b/a = 1.4

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
		$(Ew/q_oh) \times 10^{-3}$					
1	0	-1273	-1273	-1273	-1273	-1274	-1274
	0.25	-757	-757	-756	-756	-756	-756
	0.50	447	447	447	447	447	447
	0.75	1590	1590	1589	1588	1587	1586
	1	2046	2046	2044	2042	2040	2039
2	0	-918	-918	-918	-918	-918	-919
	0.25	-542	-542	-542	-542	-542	-542
	0.50	328	328	328	328	328	328
	0.75	1144	1144	1143	1142	1141	1140
	1	1467	1467	1465	1463	1461	1460
3	0	-757	-757	-757	-758	-758	-758
	0.25	-446	-446	-447	-447	-447	-447
	0.50	272	272	271	271	271	270
	0.75	945	944	943	942	941	940
	1	1210	1210	1208	1206	1204	1204
4	0	-541	-541	-541	-542	-542	-542
	0.25	-317	-317	-317	-317	-317	-317
	0.50	198	198	198	197	197	197
	0.75	675	675	674	672	671	670
	1	862	861	860	858	856	855
		$(Ev/q_oh) \times 10^{-3}$					
1	0	0	0	0	0	0	0
	0.25	-626	-626	-626	-626	-626	-626
	0.50	-730	-730	-730	-730	-730	-730
	0.75	-406	-406	-406	-406	-406	-406
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	-451	-451	-451	-451	-451	-451
	0.50	-524	-524	-524	-524	-524	-524
	0.75	-290	-290	-290	-290	-290	-290
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	-372	-372	-372	-372	-372	-372
	0.50	-432	-432	-432	-432	-432	-432
	0.75	-239	-239	-239	-239	-239	-239
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	-266	-266	-266	-266	-266	-266
	0.50	-308	-308	-308	-308	-308	-308
	0.75	-170	-170	-170	-170	-170	-170
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE B17

AXIAL MEMBRANE AND BENDING STRESSES,

$-(\sigma_{xm}/q_o) \times 10$ AND $(\sigma_{xb}/q_o) \times 10$, FOR MEDIAN LINE RINGS, b/a = 1.5

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
		$(-\sigma_{xm}/q_o) \times 10$					
	0	98	95	87	77	66	62
	0.25	660	662	667	674	681	684
1	0.50	427	427	429	431	433	434
	0.75	203	202	197	190	183	180
	1	775	776	782	789	796	799
	0	127	125	118	108	99	94
	0.25	638	640	645	651	657	660
2	0.50	429	429	430	432	433	434
	0.75	225	224	219	213	206	203
	1	743	744	749	756	762	765
	0	172	170	164	156	148	144
	0.26	607	608	612	618	623	626
3	0.50	427	428	429	430	431	432
	0.75	257	255	251	246	240	238
	1	701	702	706	712	717	719
	0	204	202	197	190	183	180
	0.25	583	584	588	593	598	600
4	0.50	429	429	430	431	432	433
	0.75	281	280	276	271	266	264
	1	665	666	670	675	680	682
		$(\sigma_{xb}/q_o) \times 10$					
	0	-1367	-1387	-1455	-1591	-1827	-2197
	0.25	-1111	-1103	-1081	-1050	-1016	-988
1	0.50	-10	-0.8	31	96	210	392
	0.75	1770	1688	1438	1014	403	-405
	1	2707	2559	2108	1327	179	-1373
	0	-968	-985	-1044	-1162	-1365	-1682
	0.25	-812	-804	-783	-752	-718	-686
2	0.50	15	21	42	87	167	300
	0.75	1479	1396	1145	716	97	-723
	1	2272	2127	1682	914	-212	-1734
	0	-740	-758	-821	-953	-1189	-1566
	0.25	-597	-596	-598	-615	-663	-761
3	0.50	129	123	104	74	32	-16
	0.75	1394	1306	1039	581	-83	-966
	1	2076	1932	1494	737	-368	-1855
	0	-505	-521	-576	-690	-894	-1219
	0.25	-414	-414	-417	-436	-485	-582
4	0.50	155	146	116	64	-13	-113
	0.75	1216	1128	860	401	-265	-1154
	1	1800	1660	1231	494	-582	-2028

*Case, see Table 1

TABLE B18

CIRCUMFERENTIAL MEMBRANE AND BENDING STRESSES,

$(\sigma_{sm}/q_o) \times 10$ AND (σ_{sb}/q_o), FOR MEDIAN LINE RINGS, b/a = 1.5

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
		$(\sigma_{sm}/q_o) \times 10$					
	0	349	370	428	512	597	639
	0.25	-1463	-1467	-1479	-1494	-1507	-1512
1	0.50	-651	-656	-670	-691	-713	-724
	0.75	-32	-8	56	146	231	270
	1	-2037	-2009	-1932	-1825	-1722	-1675
	0	266	284	334	407	481	517
	0.25	-1386	-1390	-1401	-1416	-1429	-1434
2	0.50	-663	-667	-676	-690	-704	-712
	0.75	-107	-83	-18	72	158	198
	1	-1924	-1896	-1820	-1714	-1613	-1565
	0	153	174	231	314	398	440
	0.25	-1257	-1255	-1248	-1236	-1222	-1215
3	0.50	-641	-637	-627	-613	-600	-593
	0.75	-165	-140	-70	26	118	160
	1	-1717	-1689	-1614	-1509	-1409	-1363
	0	59	77	127	200	273	310
	0.25	-1174	-1172	-1164	-1151	-1137	-1129
4	0.50	-656	-650	-634	-613	-593	-583
	0.75	-247	-222	-152	-56	36	79
	1	-1592	-1565	-1490	-1388	-1289	-1244
		(σ_{sb}/q_o)					
	0	-526	-526	-529	-534	-541	-553
	0.25	-355	-355	-354	-353	-352	-351
1	0.50	29	30	31	34	38	44
	0.75	375	372	365	352	333	309
	1	507	502	488	463	428	381
	0	-383	-384	-386	-390	-396	-406
	0.25	-256	-255	-255	-254	-252	-251
2	0.50	27	28	29	31	34	38
	0.75	276	273	266	252	234	209
	1	368	364	350	326	291	245
	0	-315	-316	-318	-322	-330	-341
	0.25	-209	-209	-209	-209	-210	-213
3	0.50	27	27	27	26	26	25
	0.75	233	230	222	208	188	161
	1	309	305	291	267	233	188
	0	-288	-228	-230	-234	-240	-250
	0.25	-148	-148	-148	-149	-150	-153
4	0.50	24	24	24	23	21	18
	0.75	173	170	162	148	128	101
	1	227	222	209	186	153	109

*Case, see Table 1

TABLE B19

SHEAR MEMBRANE AND BENDING STRESSES,

$(\tau_{xsm}/q_o) \times 10^3$ AND $(\tau_{xsb}/q_o) \times 10^2$, FOR MEDIAN LINE RINGS, b/a = 1.5

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				$(\tau_{xsm}/q_o) \times 10^3$			
	0	0	0	0	0	0	0
	0.25	0	-638	-1061	-1094	-657	149
1	0.50	0	453	791	928	844	604
	0.75	0	1279	2179	2407	1851	704
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-484	-792	-778	-377	329
2	0.50	0	477	831	974	880	617
	0.75	0	1158	1967	2156	1622	544
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-413	-693	-726	-458	50
3	0.50	0	409	720	864	827	666
	0.75	0	991	1710	1948	1628	892
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-247	-399	-373	-126	298
4	0.50	0	427	751	901	858	682
	0.75	0	851	1462	1647	1340	666
	1	0	0	0	0	0	0
				$(\tau_{xsb}/q_o) \times 10^2$			
	0	0	0	0	0	0	0
	0.25	0	-176	-316	-377	-298	0
1	0.50	0	189	331	379	285	0
	0.75	0	443	784	913	701	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-153	-275	-326	-258	0
2	0.50	0	191	334	384	289	0
	0.75	0	422	747	869	667	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-115	-207	-248	-198	0
3	0.50	0	182	319	364	273	0
	0.75	0	373	658	763	583	0
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	-91	-164	-197	-157	0
4	0.50	0	182	319	365	274	0
	0.75	0	349	616	713	543	0
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE B20

RADIAL AND CIRCUMFERENTIAL DEFORMATIONS,

$(Ew/q_o h) \times 10^{-3}$ AND $(Ev/q_o h) \times 10^{-3}$, FOR MEDIAN LINE RINGS, b/a = 1.5

*	$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				$(Ew/q_o h) \times 10^{-3}$			
	0	-1372	-1372	-1372	-1373	-1373	-1374
	0.25	-781	-781	-781	-780	-780	-780
1	0.50	603	603	603	603	604	604
	0.75	1924	1924	1923	1922	1920	1920
	1	2453	2453	2451	2448	2446	2445
	0	-990	-990	-991	-991	-992	-992
	0.25	-560	-560	-559	-559	-559	-559
2	0.50	441	441	441	441	441	441
	0.75	1385	1384	1383	1382	1380	1380
	1	1759	1758	1757	1754	1752	1750
	0	-817	-817	-817	-818	-818	-818
	0.25	-461	-461	-461	-461	-461	-461
3	0.50	365	365	365	365	365	365
	0.75	1143	1142	1141	1140	1138	1138
	1	1451	1450	1448	1446	1443	1442
	0	-585	-585	-585	-586	-586	-586
	0.25	-327	-327	-327	-327	-328	-328
4	0.50	266	266	266	265	265	265
	0.75	817	816	815	814	812	812
	1	1033	1032	1030	1028	1026	1025
				$(Ev/q_o h) \times 10^{-3}$			
	0	0	0	0	0	0	0
	0.25	-709	-709	-709	-709	-709	-709
1	0.50	-791	-791	-791	-791	-791	-791
	0.75	-410	-410	-410	-410	-410	-410
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-511	-511	-511	-511	-511	-511
2	0.50	-569	-569	-569	-569	-569	-569
	0.75	-293	-293	-293	-293	-293	-293
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-422	-422	-422	-422	-422	-422
3	0.50	-469	-469	-469	-469	-469	-469
	0.75	-242	-242	-242	-242	-242	-242
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	-302	-302	-302	-302	-302	-302
4	0.50	-335	-335	-335	-335	-335	-335
	0.75	-172	-172	-172	-172	-172	-171
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE C1

AXIAL AND CIRCUMFERENTIAL BENDING STRESSES,

$(\sigma_{xb}/q_o) \times 10$ AND $(\sigma_{sb}/q_o) \times 10^2$,

FOR SHELL WITH CIRCULAR CROSS SECTION

Ring Location	*	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				$(\sigma_{xb}/q_o) \times 10$			
Inside Case *A0	1	190	172	112	-0.8	-181	-445
	2	192	174	113	-0.8	-183	-449
	3	270	244	159	-1	-257	-631
	4	273	246	160	-1	-260	-637
Outside Case *C0	1	174	157	102	-0.7	-165	-406
	2	172	155	100	-0.7	-163	-400
	3	251	226	147	-1	-239	-586
	4	248	224	146	-1	-236	-579
Median Line Case *B0	1,2	182	164	107	-0.8	-174	-426
	3,4	261	235	153	-1	-248	-609
				$(\sigma_{sb}/q_o) \times 10^2$			
Inside Case *A0	1	572	515	335	-2	-544	-1334
	2	578	521	339	-2	-550	-1348
	3	811	732	476	-3	-772	-1894
	4	818	738	480	-3	-779	-1910
Outside Case *C0	1	521	470	306	-2	-496	-1217
	2	515	464	302	-2	-490	-1201
	3	752	678	441	-3	-716	-1756
	4	744	671	437	-3	-708	-1738
Median Line Case *B0	1,2	547	493	321	-2	-520	-1277
	3,4	783	706	459	-3	-745	-1827

*Case, see Table 1

TABLE C2

CIRCUMFERENTIAL MEMBRANE STRESSES AND RADIAL DEFORMATIONS,

$(\sigma_{sm}/q_o) \times 10$ AND $(Ew/q_o h) \times 10^{-1}$

FOR SHELL WITH CIRCULAR CROSS SECTION

Ring Location	*	2x/L: 0	0.2	0.4	0.6	0.8	1.0
				$(\sigma_{sm}/q_o) \times 10$			
Inside Case *A0	1	-819	-809	-779	-736	-695	-675
	2	-818	-808	-777	-734	-692	-672
	3	-778	-763	-721	-661	-602	-573
	4	-777	-762	-719	-658	-599	-570
Outside Case *C0	1	-828	-818	-791	-752	-714	-696
	2	-829	-819	-792	-754	-717	-699
	3	-788	-774	-735	-679	-625	-598
	4	-790	-776	-737	-682	-628	-602
Median Line Case *B0	1,2	-824	-813	-785	-744	-704	-685
	3,4	-783	-769	-728	-670	-613	-586
				$(Ew/q_o h) \times 10^{-1}$			
Inside Case *A0	1	625	615	588	549	511	493
	2	624	614	586	547	509	490
	3	588	574	535	480	426	400
	4	586	572	533	478	423	397
Outside Case *C0	1	633	624	599	564	529	512
	2	634	625	600	566	531	515
	3	597	584	548	497	447	422
	4	598	585	549	499	449	426
Median Line Case *B0	1,2	629	620	593	556	520	502
	3,4	592	579	541	488	436	411

*Case, see Table 1

TABLE D1

RADIAL AND CIRCUMFERENTIAL INTERACTION LOADS ON RING,

$(Z/q_oh) \times 10^2$ AND $-(S/q_oh) \times 10$ FOR INSIDE RINGS

*	$4s/L_o$	b/a 1.0	1.1	1.2	1.3	1.4	1.5
		$(Z/q_oh) \times 10^2$					
	0	428	1561	2863	4224	5555	6800
	0.25	428	1192	2015	2845	3636	4365
1	0.50	428	427	423	423	434	459
	0.75	428	-158	-528	-712	-744	-655
	1	428	-348	-733	-806	-639	-299
	0	433	1290	2327	3374	4456	5494
	0.25	433	1010	1649	2296	2932	3529
2	0.50	433	436	413	439	442	450
	0.75	433	5	-254	-365	-365	-276
	1	433	-131	-364	-391	-207	113
	0	608	1700	2932	4203	5429	6562
	0.25	608	1344	2122	2896	3627	4294
3	0.50	608	603	589	581	587	611
	0.75	608	30	-346	-547	-601	-535
	1	608	-158	-559	-667	-550	-267
	0	613	1445	2436	3405	4401	5346
	0.25	613	1172	1779	2382	2969	3515
4	0.50	613	611	576	600	599	607
	0.75	613	188	-83	-209	-230	-161
	1	613	52	-197	-261	-122	147
		$-(S/q_oh) \times 10$					
	0	0	0	0	0	0	0
	0.25	0	173	319	424	488	518
1	0.50	0	246	466	658	823	964
	0.75	0	175	340	506	676	845
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	139	268	352	417	457
2	0.50	0	198	374	528	662	777
	0.75	0	140	261	396	520	642
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	166	306	410	476	508
3	0.50	0	236	447	632	791	926
	0.75	0	168	327	484	643	802
	1	0	0	0	0	0	0
	0	0	0	0	0	0	0
	0.25	0	134	260	338	403	444
4	0.50	0	190	360	508	637	747
	0.75	0	134	249	380	498	612
	1	0	0	0	0	0	0

*Case, see Table I

TABLE D2

CIRCUMFERENTIAL FORCE AND BENDING MOMENT IN RING,

$(N/q_oA) \times 10$ AND $(M_ch/q_oI) \times 10$, FOR INSIDE RINGS

*	$4s/L_o$	b/a 1.0	1.1	1.2	1.3	1.4	1.5
		$(N/q_oA) \times 10$					
	0	-573	-2361	-3908	-5172	-6147	-6871
	0.25	-573	-1832	-2933	-3880	-4682	-5353
1	0.50	-573	-559	-551	-603	-736	-936
	0.75	-573	707	1869	2898	3789	4546
	1	-573	1229	2882	4414	5833	7129
	0	-579	-2048	-3372	-4411	-5278	-5951
	0.25	-579	-1613	-2522	-3303	-3974	-4540
2	0.50	-579	-569	-518	-567	-631	-740
	0.75	-579	466	1418	2257	2990	3616
	1	-579	892	2200	3453	4571	5583
	0	-464	-1444	-2214	-2968	-3492	-3879
	0.25	-464	-1153	-1697	-2250	-2671	-3020
3	0.50	-464	-453	-434	-439	-482	-563
	0.75	-464	245	850	1486	1999	2439
	1	-464	534	1388	2316	3112	3841
	0	-468	-1268	-2001	-2553	-3018	-3375
	0.25	-468	-1035	-1527	-1940	-2292	-2586
4	0.50	-468	-466	-415	-429	-441	-477
	0.75	-468	112	650	1128	1552	1916
	1	-468	355	1078	1787	2418	2991
		$(M_ch/q_oI) \times 10$					
	0	0	-442	-840	-1182	-1464	-1687
	0.25	0	-312	-589	-838	-1055	-1242
1	0.50	0	-4	-5	-21	-55	-106
	0.75	0	291	552	776	964	1121
	1	0	411	775	1100	1392	1655
	0	0	-295	-569	-797	-998	-1165
	0.25	0	-208	-394	-560	-707	-837
2	0.50	0	-5	2	-10	-25	-49
	0.75	0	189	360	506	629	733
	1	0	267	497	710	892	1055
	0	0	-293	-558	-788	-979	-1132
	0.25	0	-206	-389	-552	-695	-818
3	0.50	0	-3	0	-5	-21	-47
	0.75	0	191	364	512	638	742
	1	0	269	507	717	906	1074
	0	0	-194	-376	-529	-664	-777
	0.25	0	-138	-258	-368	-465	-549
4	0.50	0	-5	4	-2	-8	-19
	0.75	0	123	236	333	415	484
	1	0	175	323	463	581	606

*Case, see Table I

TABLE D3

RADIAL AND CIRCUMFERENTIAL INTERACTION LOADS ON RING,

$(Z/q_o h) \times 10$ AND $(S/q_o h) \times 10$ FOR OUTSIDE RINGS

*	$4s/L_o$	b/a 1.0	1.1	1.2	1.3	1.4	1.5
		$(Z/q_o h) \times 10$					
1	0	39	-152	-345	-521	-670	-792
	0.25	39	-91	-219	-339	-447	-543
	0.50	39	42	43	33	8	-26
	0.75	39	154	242	305	347	371
	1	39	194	306	390	453	501
2	0	39	-126	-293	-448	-583	-694
	0.25	39	-73	-182	-286	-379	-462
	0.50	39	42	45	41	27	4
	0.75	39	138	215	272	312	336
	1	39	173	269	340	394	434
3	0	56	-126	-310	-481	-627	-749
	0.25	56	-67	-188	-300	-402	-492
	0.50	56	60	64	60	45	21
	0.75	56	166	252	314	356	380
	1	56	205	311	388	444	484
4	0	56	-101	-260	-410	-542	-653
	0.25	56	-50	-153	-250	-336	-416
	0.50	56	59	64	65	58	44
	0.75	56	151	226	281	320	344
	1	56	184	276	342	389	422
		$(S/q_o h) \times 10$					
1	0	0	0	0	0	0	0
	0.25	0	208	386	516	596	635
	0.50	0	291	550	777	971	1135
	0.75	0	203	392	582	776	970
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	0	175	329	450	535	587
	0.50	0	243	460	650	813	953
	0.75	0	169	321	468	615	760
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	0	200	373	505	594	644
	0.50	0	280	529	748	937	1098
	0.75	0	196	376	553	732	909
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	0	168	317	438	528	589
	0.50	0	234	442	626	786	922
	0.75	0	163	309	448	583	715
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE D4

CIRCUMFERENTIAL FORCE AND BENDING MOMENT IN RING,

$(N/q_o A) \times 10$ AND $(M_c h/q_o I) \times 10$, FOR OUTSIDE RINGS

*	$4s/L_o$	b/a 1.0	1.1	1.2	1.3	1.4	1.5
		$(N/q_o A) \times 10$					
1	0	-522	1249	2754	3951	4853	5510
	0.25	-522	720	1786	2684	3432	4048
	0.50	-522	-552	-589	-570	-477	-329
	0.75	-522	-1819	-3018	-4102	-5063	-5904
	1	-522	-2343	-4040	-5647	-7161	-8565
2	0	-516	938	2186	3205	4000	4599
	0.25	-516	502	1375	2113	2730	3239
	0.50	-516	-545	-591	-613	-590	-525
	0.75	-516	-1583	-2570	-3467	-4268	-4971
	1	-516	-2010	-3394	-4687	-5896	-7013
3	0	-431	534	1351	2006	2506	2875
	0.25	-431	245	819	1299	1696	2023
	0.50	-431	-451	-484	-498	-480	-433
	0.75	-431	-1145	-1813	-2423	-2970	-3455
	1	-431	-1432	-2371	-3258	-4095	-4873
4	0	-426	366	1043	1598	2036	2371
	0.25	-426	127	598	993	1321	1591
	0.50	-426	-445	-479	-509	-520	-512
	0.75	-426	-1014	-1564	-2069	-2524	-2928
	1	-426	-1249	-2015	-2732	-3402	-4021
		$(M_c h/q_o I) \times 10$					
1	0	0	-424	-789	-1087	-1315	-1483
	0.25	0	-297	-552	-771	-955	-1108
	0.50	0	2	10	5	-20	-60
	0.75	0	292	562	801	1009	1188
	1	0	410	787	1137	1463	1763
2	0	0	-279	-519	-720	-879	-1000
	0.25	0	-196	-362	-504	-624	-725
	0.50	0	0	9	13	7	-7
	0.75	0	190	367	526	665	786
	1	0	266	512	737	945	1136
3	0	0	-289	-541	-752	-917	-1044
	0.25	0	-202	-375	-524	-650	-754
	0.50	0	1	11	15	8	-9
	0.75	0	197	379	541	681	801
	0.50	0	275	526	754	965	1156
4	0	0	-191	-358	-499	-615	-705
	0.25	0	-134	-247	-344	-427	-496
	0.50	0	0	9	16	18	14
	0.75	0	128	248	356	450	531
	1	0	179	343	491	625	747

*Case, see Table 1

TABLE D5

RADIAL AND CIRCUMFERENTIAL INTERACTION LOADS ON RING,

$(Z/q_o h) \times 10^2$ AND $-(S/q_o h) \times 10^2$ FOR MEDIAN LINE RINGS

*	$4s/L_o$	b/a 1.0	1.1	1.2	1.3	1.4	1.5
				$(Z/q_o h) \times 10^2$			
1	0	410	200	142	225	402	620
	0.25	410	256	144	63	5	-34
	0.50	410	409	329	160	-67	-308
	0.75	410	591	772	947	1111	1262
	1	410	674	1030	1475	1966	2452
2	0	410	198	110	165	322	530
	0.25	410	252	137	54	-3	-42
	0.50	410	408	352	209	3	-226
	0.75	410	595	781	961	1128	1282
	1	410	682	1021	1447	1922	2402
3	0	586	397	313	349	471	634
	0.25	586	446	343	268	214	175
	0.50	586	585	541	426	257	69
	0.75	586	752	920	1084	1240	1383
	1	586	830	1130	1503	1921	2343
4	0	586	391	291	302	400	548
	0.25	586	444	339	264	210	172
	0.50	586	588	558	468	324	154
	0.75	586	755	926	1092	1249	1394
	1	586	832	1121	1473	1869	2275
				$-(S/q_o h) \times 10^2$			
1	0	0	0	0	0	0	0
	0.25	0	15	64	62	46	30
	0.50	0	41	74	98	113	121
	0.75	0	43	42	77	114	141
	1	0	0	0	0	0	0
2	0	0	0	0	0	0	0
	0.25	0	41	75	84	77	66
	0.50	0	43	77	101	116	123
	0.75	0	20	34	58	87	109
	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
	0.25	0	45	77	73	45	10
	0.50	0	51	91	118	131	133
	0.75	0	27	52	93	140	178
	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0
	0.25	0	48	88	100	85	60
	0.50	0	52	93	121	134	136
	0.75	0	26	44	71	105	133
	1	0	0	0	0	0	0

*Case, see Table 1

TABLE D6

CIRCUMFERENTIAL FORCE AND BENDING MOMENT IN RING,

$(N/q_o A) \times 10$ AND $(M_c h/q_o I)$, FOR MEDIAN LINE RINGS

*	$4s/L_o$	b/a 1.0	1.1	1.2	1.3	1.4	1.5
				$(N/q_o A) \times 10$			
1	0	-548	-733	-893	-1019	-1112	-1182
	0.25	-548	-673	-790	-893	-981	-1055
	0.50	-548	-543	-558	-591	-639	-692
	0.75	-548	-435	-348	-290	-259	-250
	1	-548	-396	-268	-166	-90	-43
2	0	-548	-735	-909	-1048	-1150	-1228
	0.25	-548	-676	-797	-904	-995	-1072
	0.50	-548	-546	-552	-578	-621	-670
	0.75	-548	-432	-343	-281	-247	-236
	1	-548	-390	-266	-166	-92	-46
3	0	-448	-558	-656	-731	-782	-818
	0.25	-448	-523	-591	-650	-698	-737
	0.50	-448	-446	-448	-461	-485	-513
	0.75	-448	-378	-322	-282	-258	-249
	1	-448	-352	-275	-210	-160	-127
4	0	-448	-560	-663	-745	-804	-846
	0.25	-448	-524	-594	-654	-704	-745
	0.50	-448	-445	-444	-453	-472	-496
	0.75	-448	-377	-319	-277	-252	-241
	1	-448	-351	-275	-212	-164	-133
				$(M_c h/q_o I)$			
1	0	0	-184	-336	-449	-531	-593
	0.25	0	-131	-247	-346	-431	-503
	0.50	0	-2	-13	-41	-78	-119
	0.75	0	130	245	345	430	502
	1	0	185	360	529	686	838
2	0	0	-132	-244	-329	-391	-437
	0.25	0	-94	-177	-249	-310	-361
	0.50	0	-1	-7	-23	-47	-74
	0.75	0	93	176	247	308	360
	1	0	132	255	373	483	583
3	0	0	-109	-201	-272	-324	-362
	0.25	0	-77	-146	-205	-255	-298
	0.50	0	-1	-5	-18	-38	-59
	0.75	0	77	145	204	254	297
	1	0	109	210	307	397	479
4	0	0	-78	-144	-197	-236	-265
	0.25	0	-55	-104	-146	-182	-212
	0.50	0	0	-3	-10	-21	-35
	0.75	0	54	103	145	181	211
	1	0	77	148	214	277	334

*Case, see Table 1

TABLE E1

STRESSES AND DEFORMATIONS FOR CLAMPED ENDS b/a = 1.1

$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
			$-(\sigma_{xm}/q_o) \times 10$			
0	456	456	456	456	456	456
0.25	456	456	456	456	456	456
0.50	457	457	457	457	457	457
0.75	458	457	457	457	457	457
1	457	457	457	457	457	457
			$(\sigma_{xb}/q_o) \times 10$			
0	514	467	312	10	-494	-1255
0.25	542	491	325	6	-520	-1305
0.50	615	554	360	-3	-585	-1435
0.75	695	624	399	-13	-656	-1576
1	730	654	415	-18	-688	-1638
			$-(\sigma_{sm}/q_o) \times 10$			
0	591	558	465	332	201	137
0.25	595	562	467	334	201	137
0.50	602	568	471	335	201	137
0.75	605	570	472	335	201	137
1	604	569	471	334	201	137
			$(\sigma_{sb}/q_o) \times 10$			
0	153	139	92	2	-148	-376
0.25	161	146	97	2	-156	-392
0.50	184	166	108	-1	-176	-430
0.75	210	188	120	-3	-197	-473
1	221	198	126	-4	-206	-491
			$(\tau_{xsm}/q_o) \times 10^4$			
0	0	0	0	0	0	0
0.25	0	491	873	1090	1164	1179
0.50	0	339	583	692	709	713
0.75	0	-11	-49	-111	-162	-171
1	0	0	0	0	0	0
			$(\tau_{xsb}/q_o) \times 10^3$			
0	0	0	0	0	0	0
0.25	0	242	418	467	340	0
0.50	0	377	650	725	526	0
0.75	0	291	501	558	404	0
1	0	0	0	0	0	0
			$(Ew/q_o h) \times 10^{-1}$			
0	364	337	263	157	51	0
0.25	381	353	275	164	53	0
0.50	427	396	307	182	59	0
0.75	477	442	342	202	65	0
1	499	462	357	210	68	0
			$(Ev/q_o h) \times 10^3$			
0	0	0	0	0	0	0
0.25	-2574	-2426	-2013	-1416	-726	0
0.50	-1627	-1525	-1248	-864	-438	0
0.75	273	269	248	194	106	0
1	0	0	0	0	0	0

TABLE E2

STRESSES AND DEFORMATIONS FOR CLAMPED ENDS b/a - 1.2*

$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
			$-(\sigma_{xm}/q_o) \times 10$			
0	450	450	450	450	450	450
0.25	452	452	452	452	452	452
0.50	454	454	454	454	454	454
0.75	454	454	454	454	454	454
1	452	452	452	452	452	452
			$(\sigma_{xb}/q_o) \times 10$			
0	437	401	275	20	-425	-1118
0.25	484	441	298	14	-467	-1201
0.50	615	554	361	-2	-585	-1435
0.75	776	694	437	-24	-730	-1718
1	850	758	472	-34	-797	-1849
			$-(\sigma_{sm}/q_o) \times 10$			
0	573	541	453	326	198	135
0.25	584	551	460	329	199	136
0.50	602	568	471	335	201	136
0.75	602	566	468	332	199	136
1	592	558	461	327	197	136
			$(\sigma_{sb}/q_o) \times 10$			
0	131	120	83	6	-128	-335
0.25	145	132	89	4	-140	-360
0.50	184	166	108	-1	-176	-431
0.75	233	208	131	-7	-219	-516
1	255	227	142	-10	-239	-555
			$(Ew/q_o h) \times 10^{-1}$			
0	315	293	229	137	45	0
0.25	345	320	249	149	49	0
0.50	427	396	307	182	59	0
0.75	528	488	377	222	71	0
1	575	531	410	240	77	0

*Results from Equivalent Circular Cylinder Solution

TABLE E3

STRESSES AND DEFORMATIONS FOR CLAMPED ENDS b/a = 1.3

$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
			$-(\sigma_{xm}/q_o) \times 10$			
0	444	444	444	444	444	444
0.25	446	446	446	446	446	446
0.50	451	450	450	450	449	449
0.75	448	448	448	448	447	447
1	443	443	443	444	445	446
			$(\sigma_{xb}/q_o) \times 10$			
0	375	346	244	27	-369	-1005
0.25	437	400	275	19	-425	-1117
0.50	620	559	363	-4	-590	-1446
0.75	852	760	473	-34	-798	-1853
1	963	856	526	-48	-896	-2045
			$-(\sigma_{sm}/q_o) \times 10$			
0	557	527	442	320	196	133
0.25	573	541	452	325	197	134
0.50	600	566	469	332	198	135
0.75	590	555	459	325	195	134
1	567	534	442	314	192	134
			$(\sigma_{sb}/q_o) \times 10$			
0	110	101	71	7	-111	-301
0.25	128	117	80	4	-128	-335
0.50	185	166	108	-2	-177	-434
0.75	259	231	144	-9	-239	-556
1	295	262	162	-12	-268	-614
			$(\tau_{xsm}/q_o) \times 10^3$			
0	0	0	0	0	0	0
0.25	0	225	406	515	556	564
0.50	0	41	64	64	54	51
0.75	0	-168	-316	-425	-480	-492
1	0	0	0	0	0	0
			$(\tau_{xsb}/q_o) \times 10^2$			
0	0	0	0	0	0	0
0.25	0	56	96	108	79	0
0.50	0	102	177	197	143	0
0.75	0	89	153	171	123	0
1	0	0	0	0	0	0
			$(Ew/q_o h) \times 10^{-1}$			
0	276	257	202	122	40	0
0.25	315	293	229	137	45	0
0.50	431	399	310	183	60	0
0.75	576	532	410	241	77	0
1	644	595	458	268	86	0
			$(Ev/q_o h) \times 10^2$			
0	0	0	0	0	0	0
0.25	-1218	-1150	-958	-677	-348	0
0.50	-148	-136	-105	-67	-32	0
0.75	1009	958	810	582	303	0
1	0	0	0	0	0	0

TABLE E4

STRESSES AND DISPLACEMENTS FOR CLAMPED ENDS b/a = 1.4*

$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
			$-(\sigma_{xm}/q_o) \times 10$			
0	436	436	436	436	436	436
0.25	439	439	439	439	439	439
0.50	446	446	446	446	446	446
0.75	440	440	440	440	440	440
1	432	432	432	432	432	432
			$(\sigma_{xb}/q_o) \times 10$			
0	332	309	224	33	-329	-926
0.25	398	367	256	25	-389	-1048
0.50	617	556	362	-2	-587	-1440
0.75	930	827	509	-45	-868	-1988
1	1078	954	578	-66	-1000	-2244
			$-(\sigma_{sm}/q_o) \times 10$			
0	536	508	428	311	191	131
0.25	560	530	444	320	194	132
0.50	601	567	470	333	198	134
0.75	575	541	447	316	191	132
1	524	494	409	293	182	130
			$(\sigma_{sb}/q_o) \times 10$			
0	100	93	67	10	-99	-278
0.25	119	110	77	8	-117	-314
0.50	185	167	108	-1	-176	-432
0.75	279	248	153	-14	-260	-596
1	323	286	174	-20	-300	-673
			$(Ew/q_o h) \times 10^{-1}$			
0	248	231	182	110	37	0
0.25	291	270	212	128	42	0
0.50	429	397	308	182	59	0
0.75	624	577	444	260	83	0
1	717	661	508	297	94	0

*Results from Equivalent Circular Cylinder Solution

TABLE E5

STRESSES AND DEFORMATIONS FOR CLAMPED ENDS b/a = 1.5

$4s/L_o$	2x/L: 0	0.2	0.4	0.6	0.8	1.0
			$-(\sigma_{xm}/q_o) \times 10$			
0	429	429	429	429	429	430
0.25	432	432	432	433	433	434
0.50	441	441	440	439	438	436
0.75	432	432	431	431	430	430
1	416	417	419	421	423	425
			$(\sigma_{xb}/q_o) \times 10$			
0	288	270	201	36	-290	-844
0.25	367	340	241	27	-363	-992
0.50	630	567	368	-5	-600	-1464
0.75	992	880	539	-52	-922	-2097
1	1171	1035	623	-76	-1081	-2406
			$-(\sigma_{sm}/q_o) \times 10$			
0	523	496	420	307	190	129
0.25	549	520	436	315	192	130
0.50	598	563	465	328	194	131
0.75	551	518	428	304	185	129
1	482	455	380	276	176	127
			$(\sigma_{sb}/q_o) \times 10$			
0	83	78	58	9	-87	-253
0.25	106	98	69	6	-109	-298
0.50	186	168	108	-2	-180	-439
0.75	302	268	165	-14	-276	-629
1	361	319	194	-19	-323	-722
			$(\tau_{xsm}/q_o) \times 10^3$			
0	0	0	0	0	0	0
0.25	0	446	805	1026	1112	1126
0.50	0	-53	-116	-182	-229	-243
0.75	0	-521	-969	-1283	-1436	-1470
1	0	0	0	0	0	0
			$(\tau_{xsb}/q_o) \times 10^2$			
0	0	0	0	0	0	0
0.25	0	75	129	146	106	0
0.50	0	154	265	296	214	0
0.75	0	143	246	273	197	0
1	0	0	0	0	0	0
			$(Ew/q_o h) \times 10^{-1}$			
0	221	206	163	99	33	0
0.25	272	253	198	120	40	0
0.50	437	405	314	186	60	0
0.75	663	612	471	275	88	0
1	774	714	548	319	102	0
			$(Ev/q_o h) \times 10$			
0	0	0	0	0	0	0
0.25	-243	-230	-192	-135	-70	0
0.50	43	42	37	27	15	0
0.75	304	289	243	174	90	0
1	0	0	0	0	0	0

TABLE E6

STRESSES AND DEFORMATIONS FOR CLAMPED CIRCULAR CYLINDER

Quantity	2x/L: 0	0.2	0.4	0.6	0.8	1.0
$(\sigma_{xb}/q_o) \times 10$	614	554	360	-2	-584	-1433
$(\sigma_{sb}/q_o) \times 10$	184	166	108	-1	-175	-430
$(\sigma_{sm}/q_o) \times 10$	-603	-568	-472	-336	-202	-138
$(Ew/q_o h) \times 10^{-1}$	427	395	306	182	59	0

TABLE E7

RADIAL AND CIRCUMFERENTIAL INTERACTION LOADS,

$(Z/q_o h) \times 10$ AND $(S/q_o h) \times 10^3$ FOR CLAMPED CYLINDERS

$4s/L_o$	b/a: 1.0	1.1	1.2*	1.3	1.4*	1.5
				$(Z/q_o h) \times 10$		
0	138	125	115	107	101	95
0.25	138	129	121	115	110	106
0.50	138	138	138	139	139	140
0.75	138	148	158	168	177	185
1	138	153	167	182	195	207
				$(S/q_o h) \times 10^3$		
0	0	0	--	0	--	0
0.25	0	-236	--	-1128	--	-2253
0.50	0	-143	--	-101	--	486
0.75	0	34	--	984	--	2940
1	0	0	--	0	--	0

*Results from Equivalent Circular Cylinder Solution

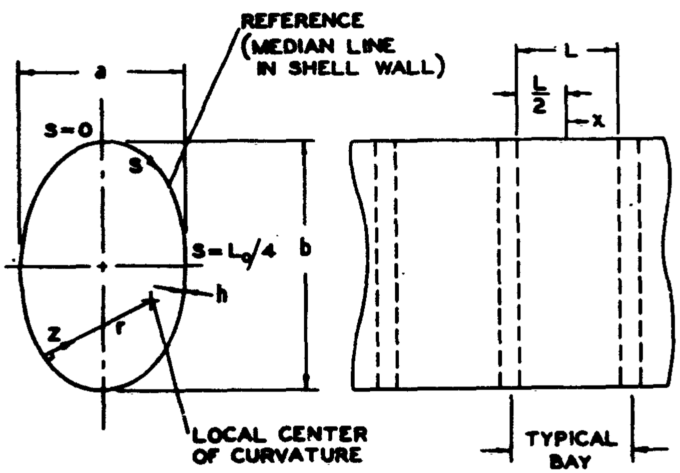

FIG. 1 RING-REINFORCED OVAL CYLINDER

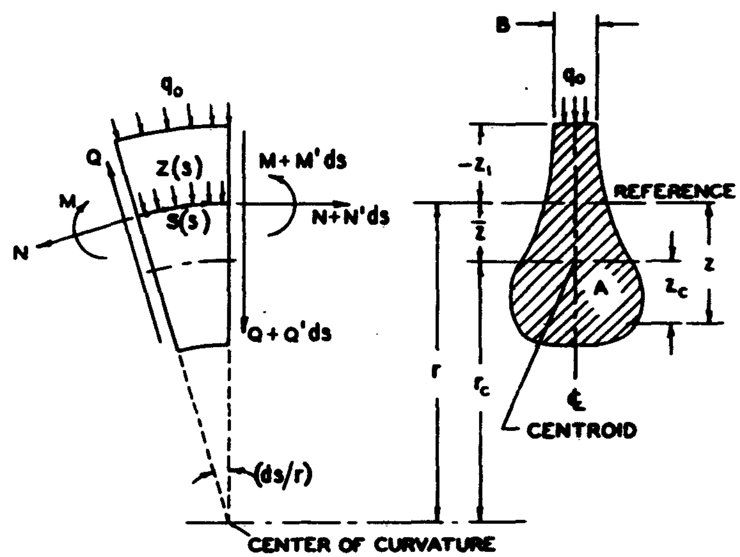

FIG. 2 ELEMENT OF OVAL RING

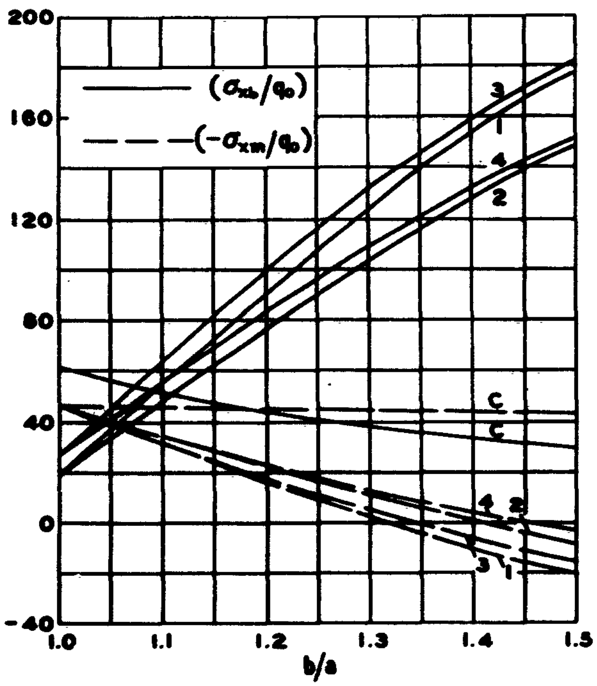

FIG. 3 AXIAL STRESS IN SHELL VS b/a AT MID-BAY, MAJOR AXIS $(x = s = 0)$ FOR INSIDE RING CASES

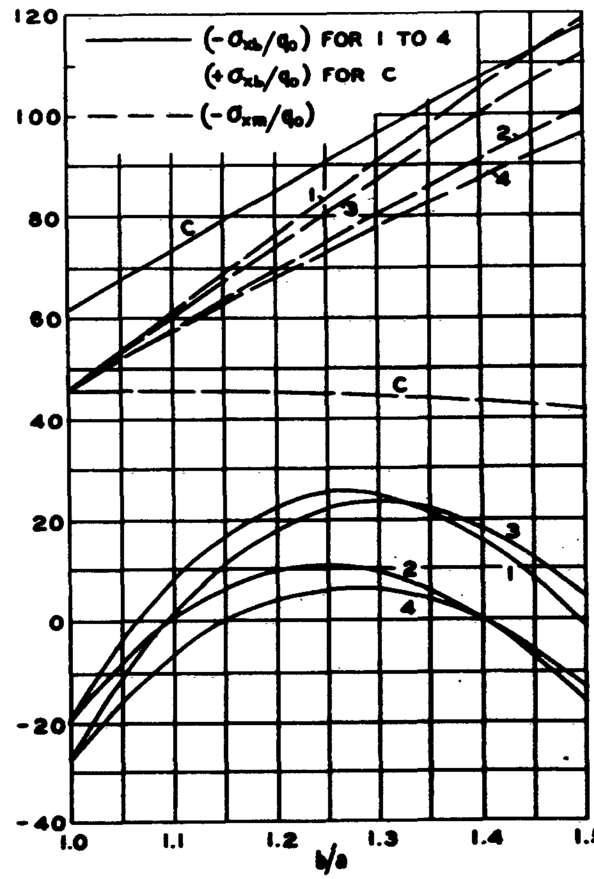

FIG. 4 AXIAL STRESS IN SHELL VS b/a AT MID-BAY, MINOR AXIS $(x = 0, s = L_0/4)$ FOR INSIDE RING CASES

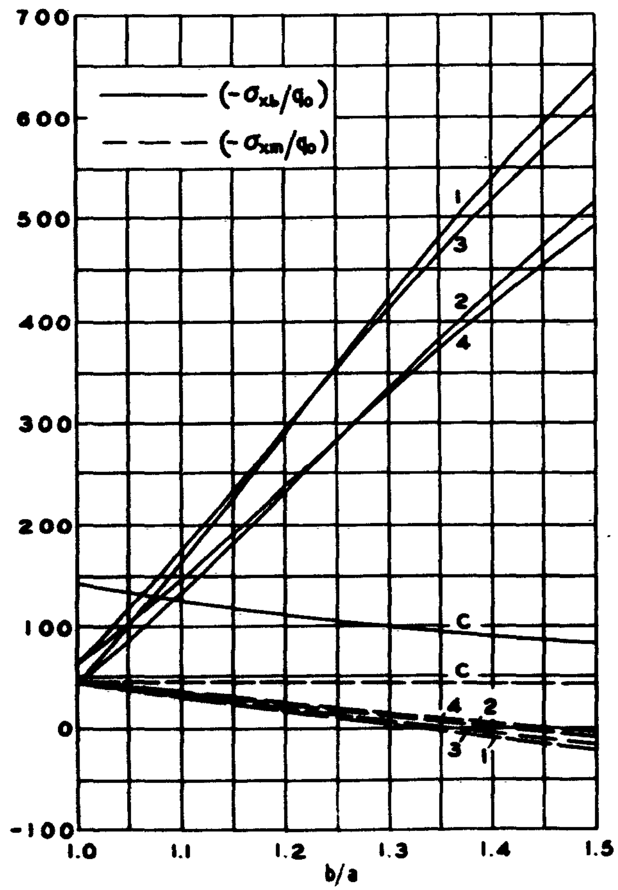

FIG. 5 AXIAL STRESS IN SHELL VS b/a AT RING, MAJOR AXIS $(x=L/2,\ s=0)$ FOR INSIDE RING CASES

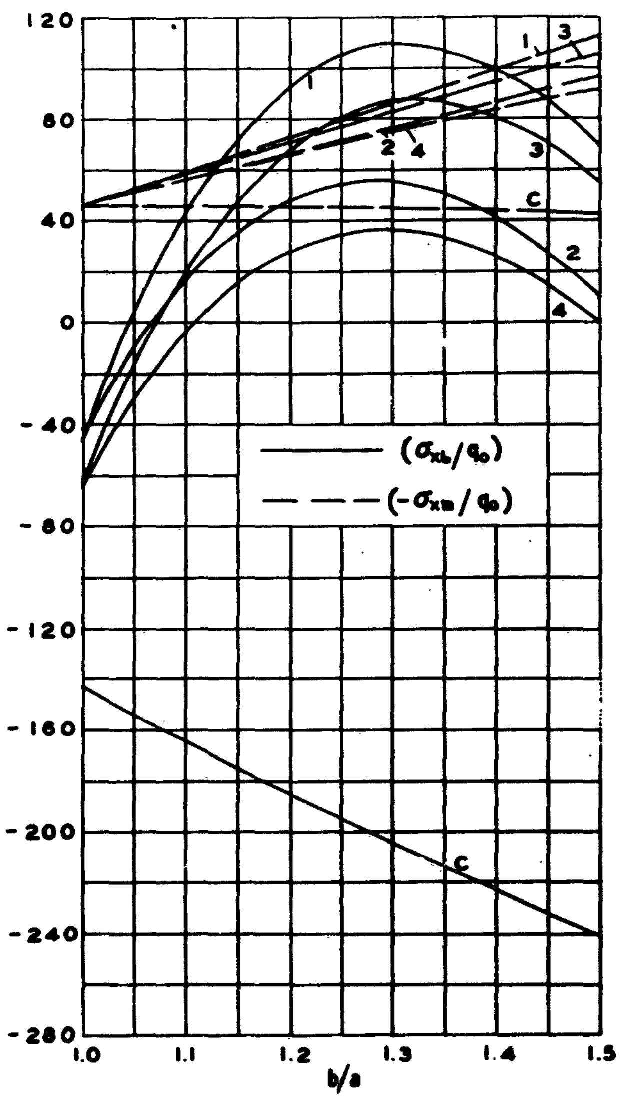

FIG. 6 AXIAL STRESS IN SHELL VS b/a AT RING, MINOR AXIS $(x=L/2,\ s=L_o/4)$ FOR INSIDE RING CASES

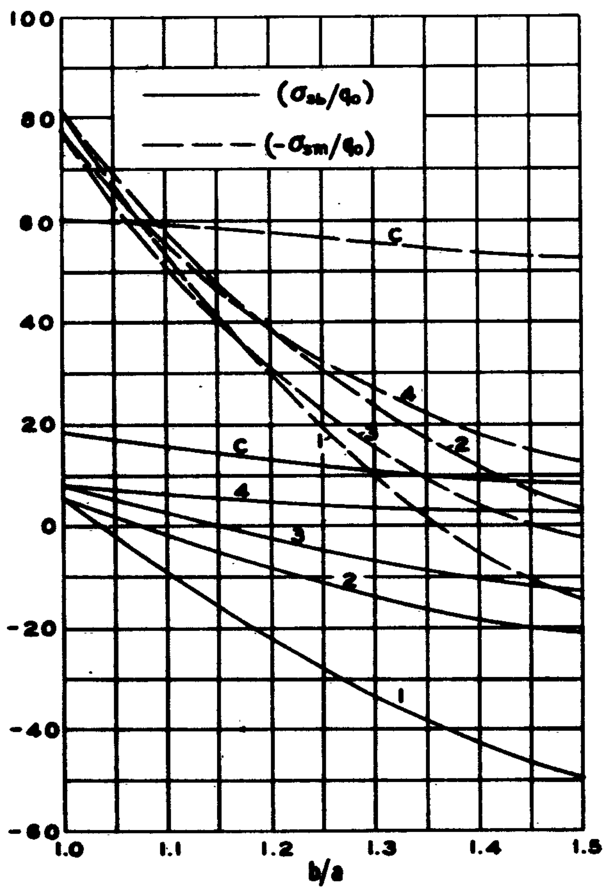

FIG. 7 CIRCUMFERENTIAL STRESS IN SHELL VS b/a AT MID-BAY, MAJOR AXIS ($x = s = 0$) FOR INSIDE RING CASES

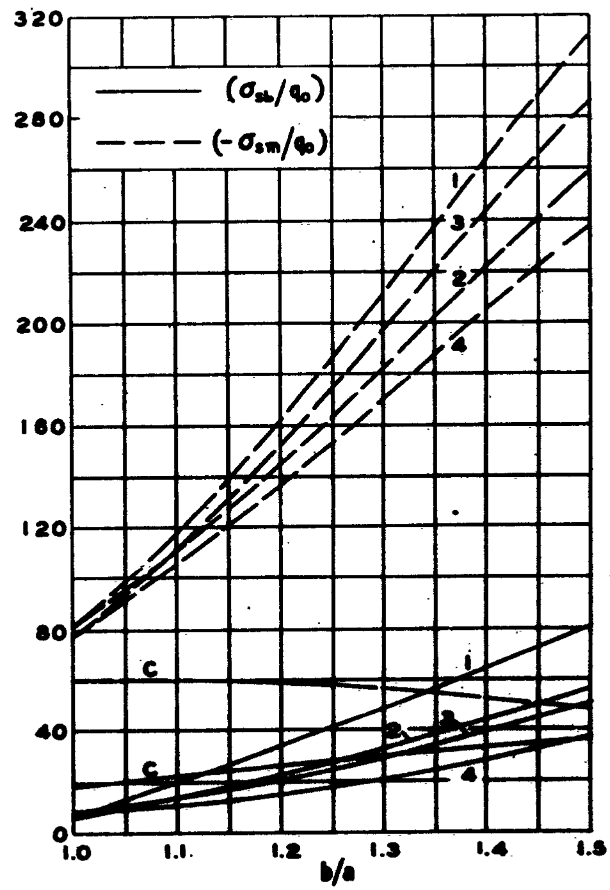

FIG. 8 CIRCUMFERENTIAL STRESS IN SHELL VS b/a AT MID-BAY, MINOR AXIS ($x = 0$, $s = L_0/4$) FOR INSIDE RING CASES

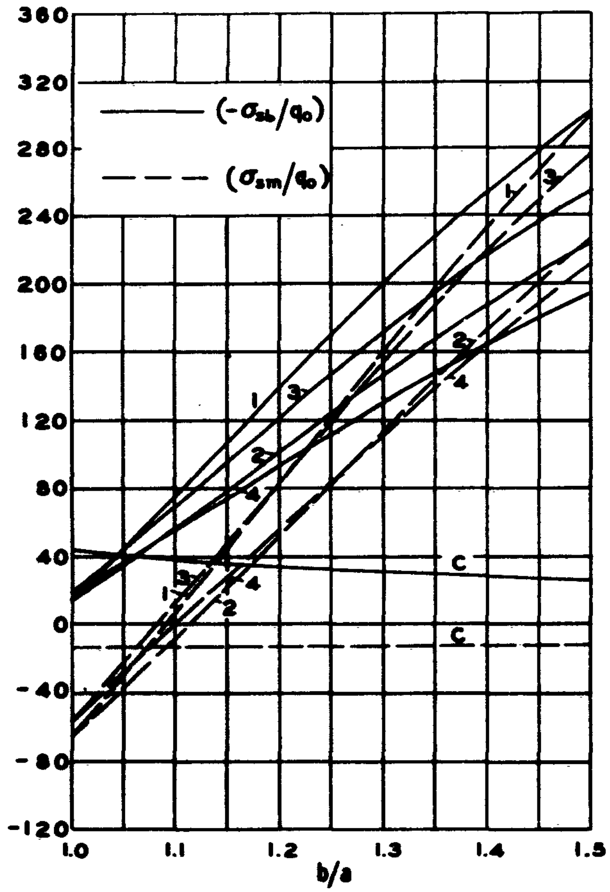

FIG. 9 CIRCUMFERENTIAL STRESS IN SHELL VS b/a AT RING, MAJOR AXIS ($x = L/2$, $s = 0$) FOR INSIDE RING CASES

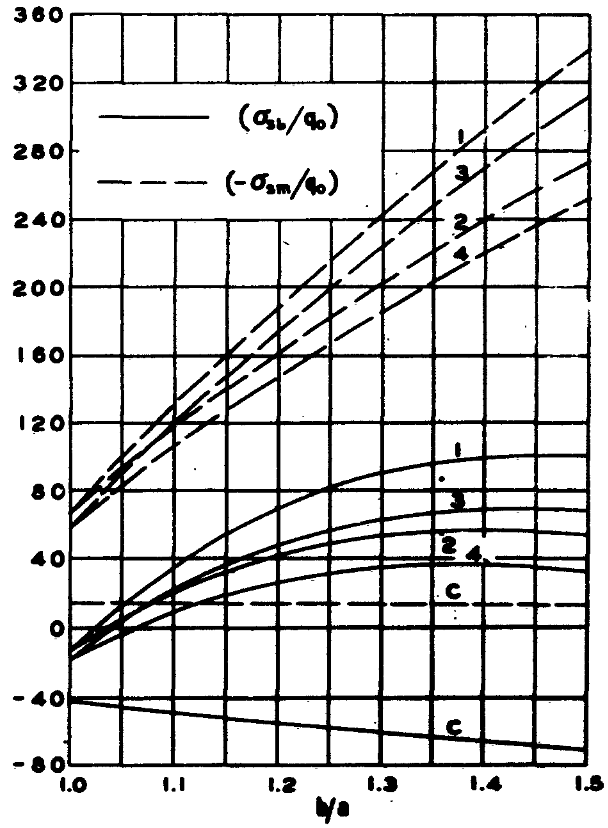

FIG. 10 CIRCUMFERENTIAL STRESS IN SHELL VS b/a AT RING, MINOR AXIS ($x = L/2$, $s = L_o/4$) FOR INSIDE RING CASES

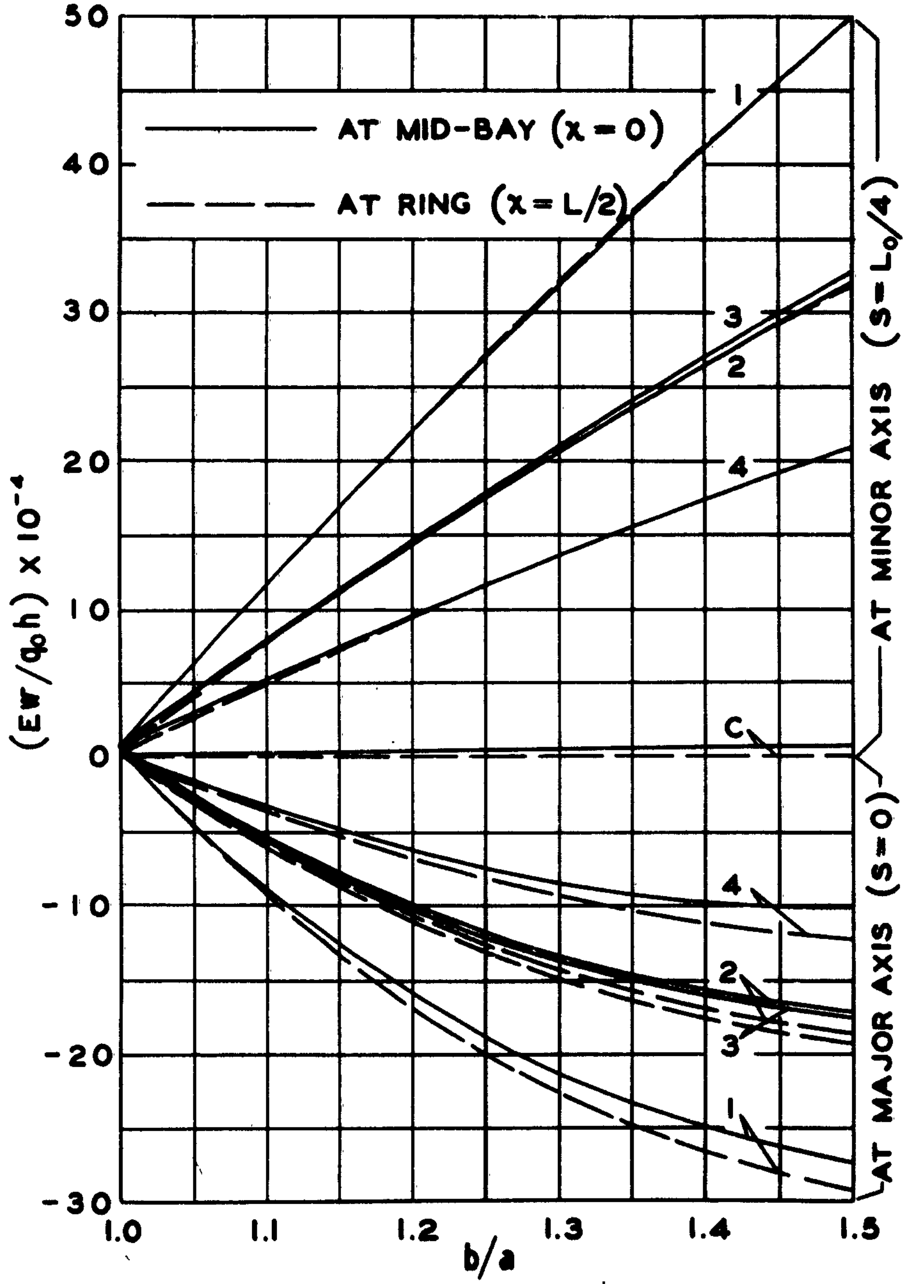

FIG. 11 RADIAL DEFORMATIONS VS b/a FOR INSIDE RING CASES

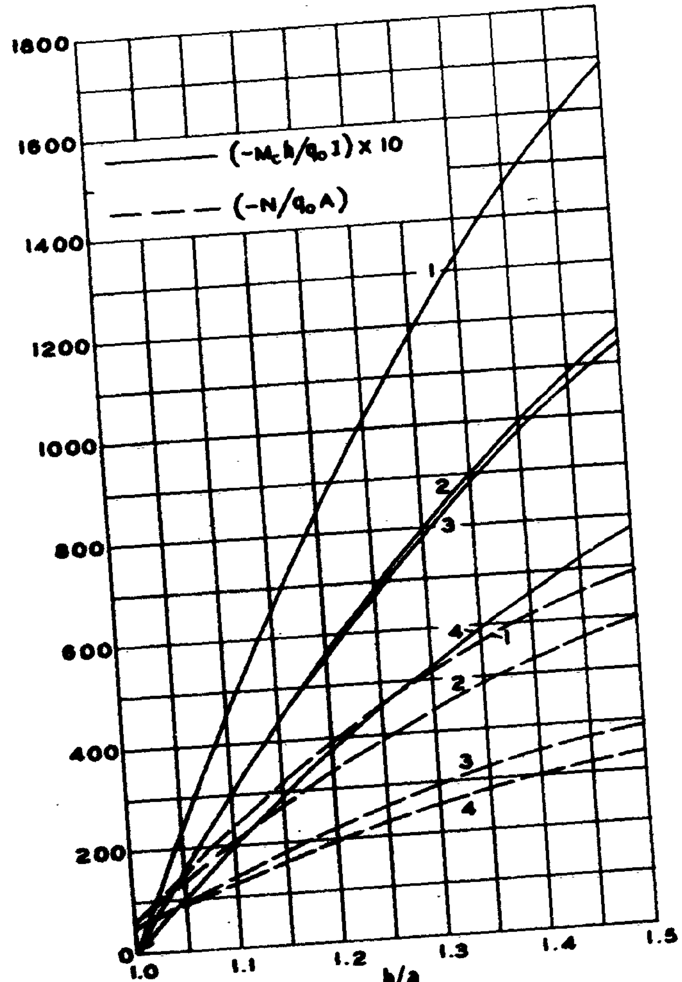

FIG. 12
CIRCUMFERENTIAL FORCE AND BENDING MOMENT IN INSIDE RINGS AT MAJOR AXIS (S=0)

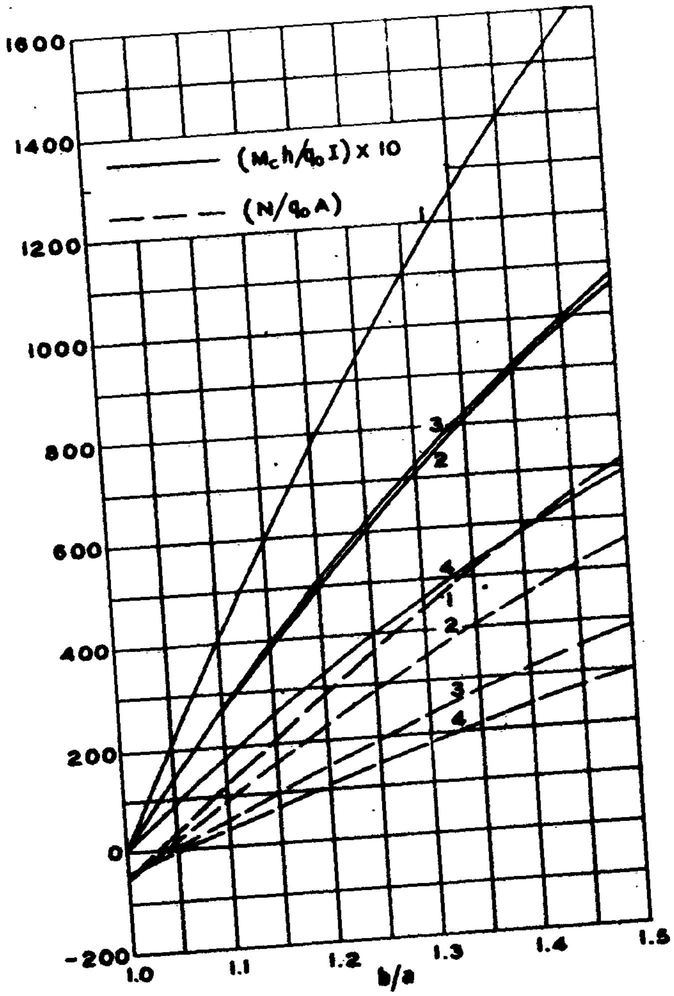

FIG. 13
CIRCUMFERENTIAL FORCE AND BENDING MOMENT IN INSIDE RINGS AT MINOR AXIS ($S = L_0/4$)

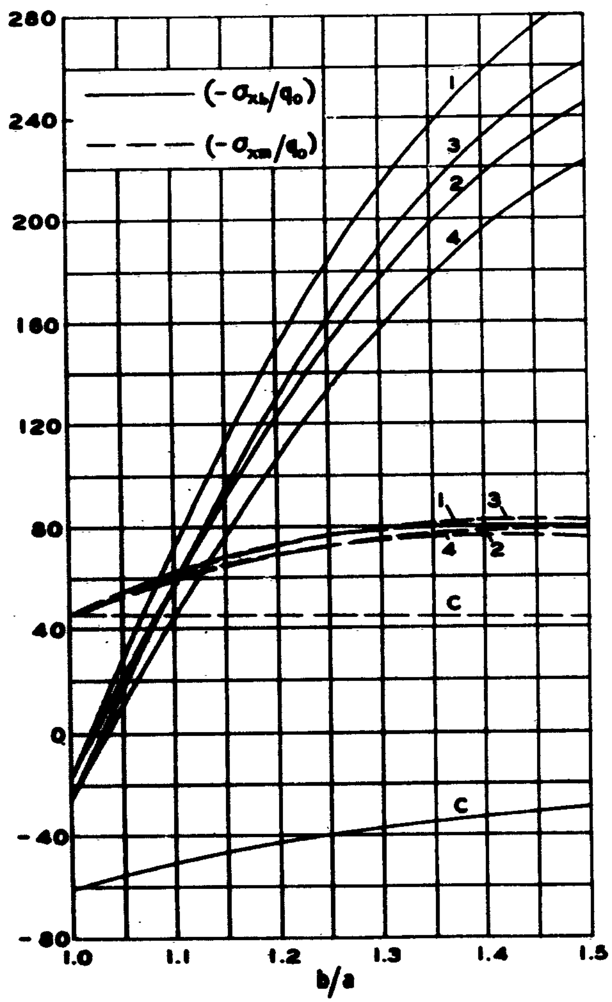

FIG. 14 AXIAL STRESS IN SHELL VS b/a AT MID-BAY, MAJOR AXIS ($x = s = 0$) FOR OUTSIDE RING CASES

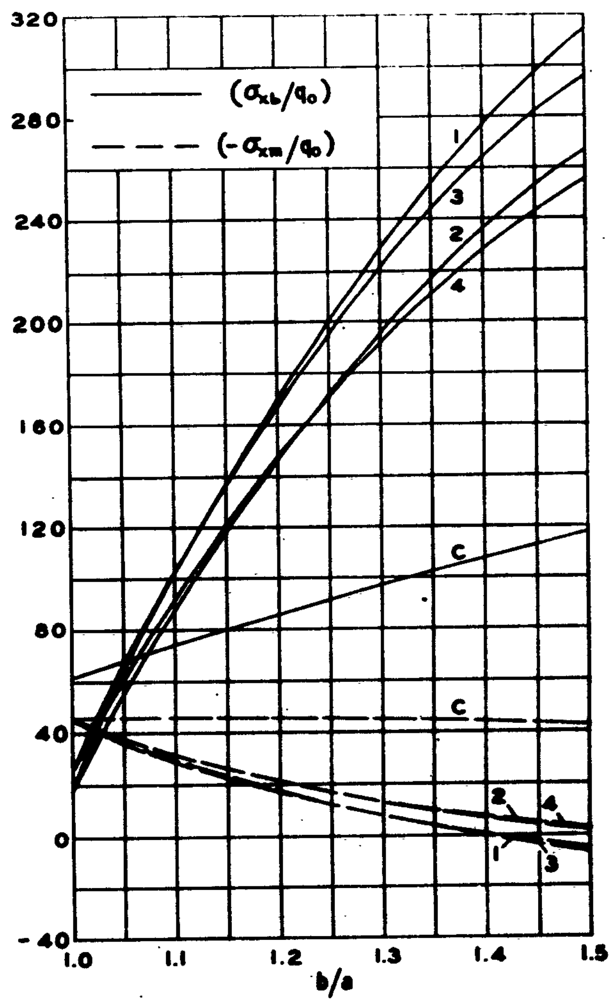

FIG. 15 AXIAL STRESS IN SHELL VS b/a AT MID-BAY, MINOR AXIS ($x = 0$, $s = L_o/4$) FOR OUTSIDE RING CASES

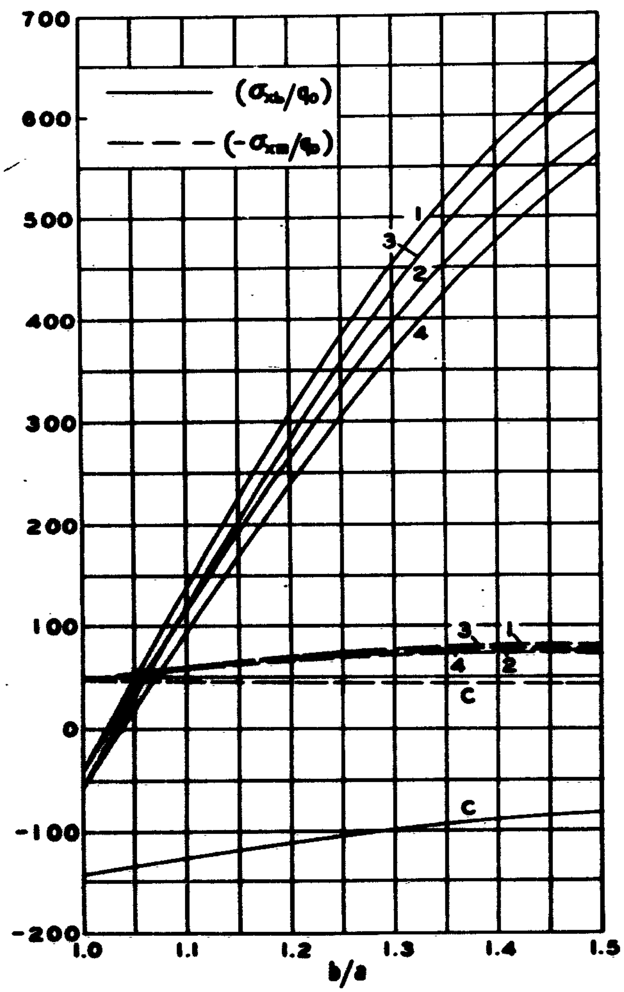

FIG. 16 AXIAL STRESS IN SHELL VS b/a AT RING, MAJOR AXIS ($x = L/2, s = 0$) FOR OUTSIDE RING CASES

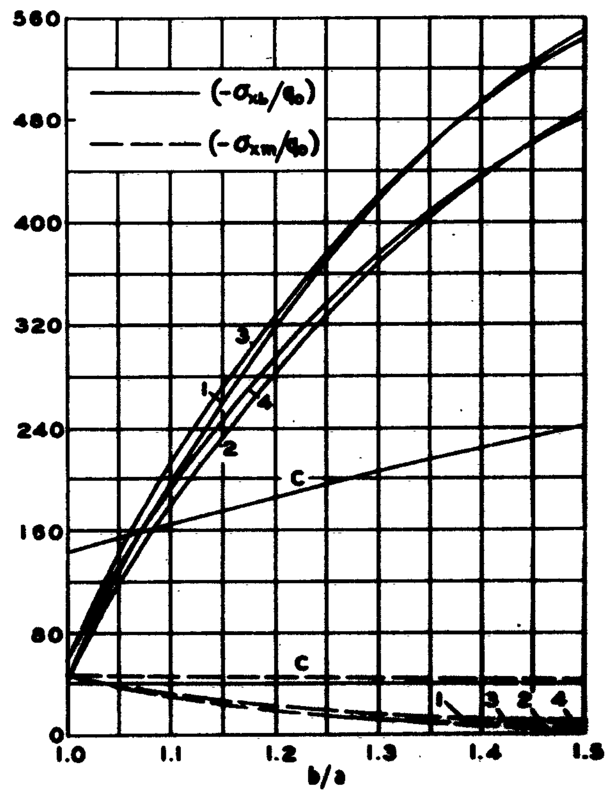

FIG. 17 AXIAL S RESS IN SHELL VS b/a AT RING, MINOR AXIS ($x = L/2, s = L_0/4$) FOR OUTSIDE RING CASES

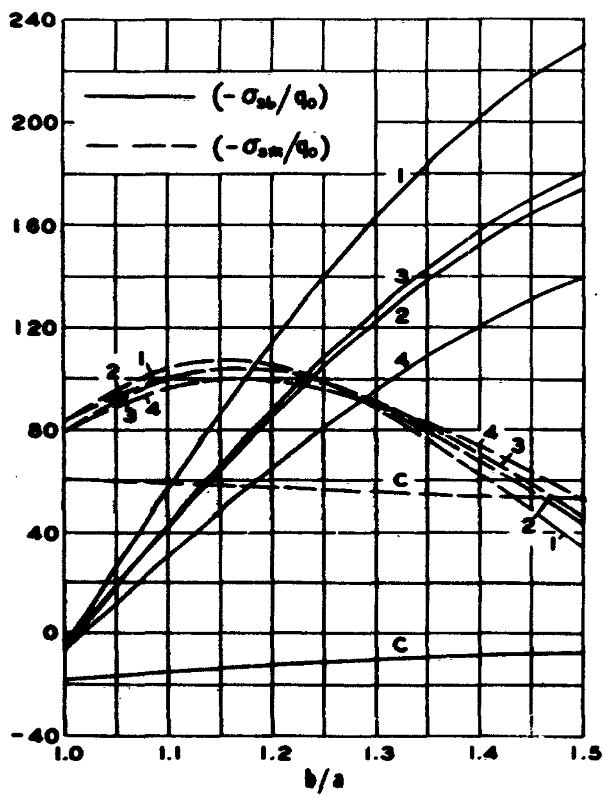

FIG. 18 CIRCUMFERENTIAL STRESS IN SHELL VS b/a AT MID-BAY, MAJOR AXIS ($x = s = 0$) FOR OUTSIDE RING CASES

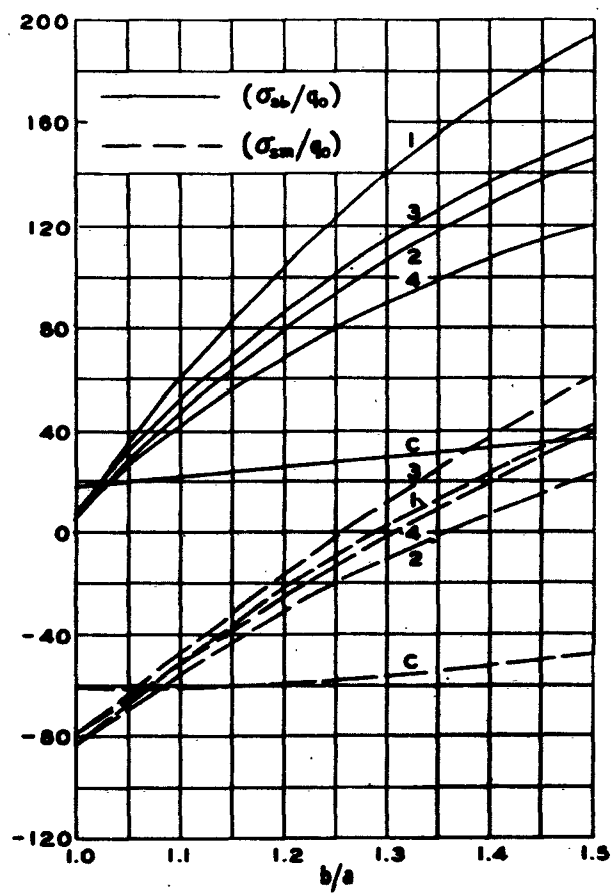

FIG. 19 CIRCUMFERENTIAL STRESS IN SHELL VS b/a AT MID-BAY, MINOR AXIS ($x = 0$, $s = L_o/4$) FOR OUTSIDE RING CASES

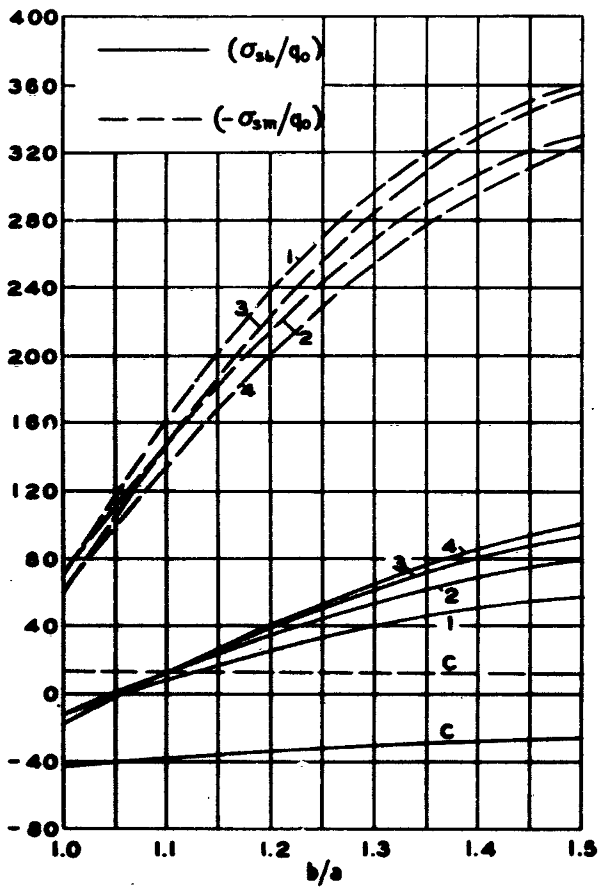

FIG. 20 CIRCUMFERENTIAL STRESS IN SHELL VS b/a AT RING, MAJOR AXIS ($x = L/2$, $s = 0$) FOR OUTSIDE RING CASES

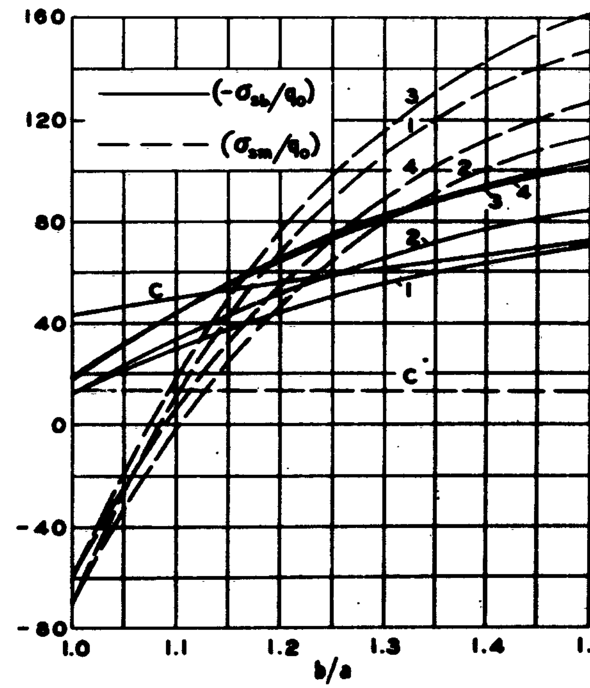

FIG. 21 CIRCUMFERENTIAL STRESS IN SHELL VS b/a AT RING, MINOR AXIS ($x = L/2$, $s = L_o/4$) FOR OUTSIDE RING CASES

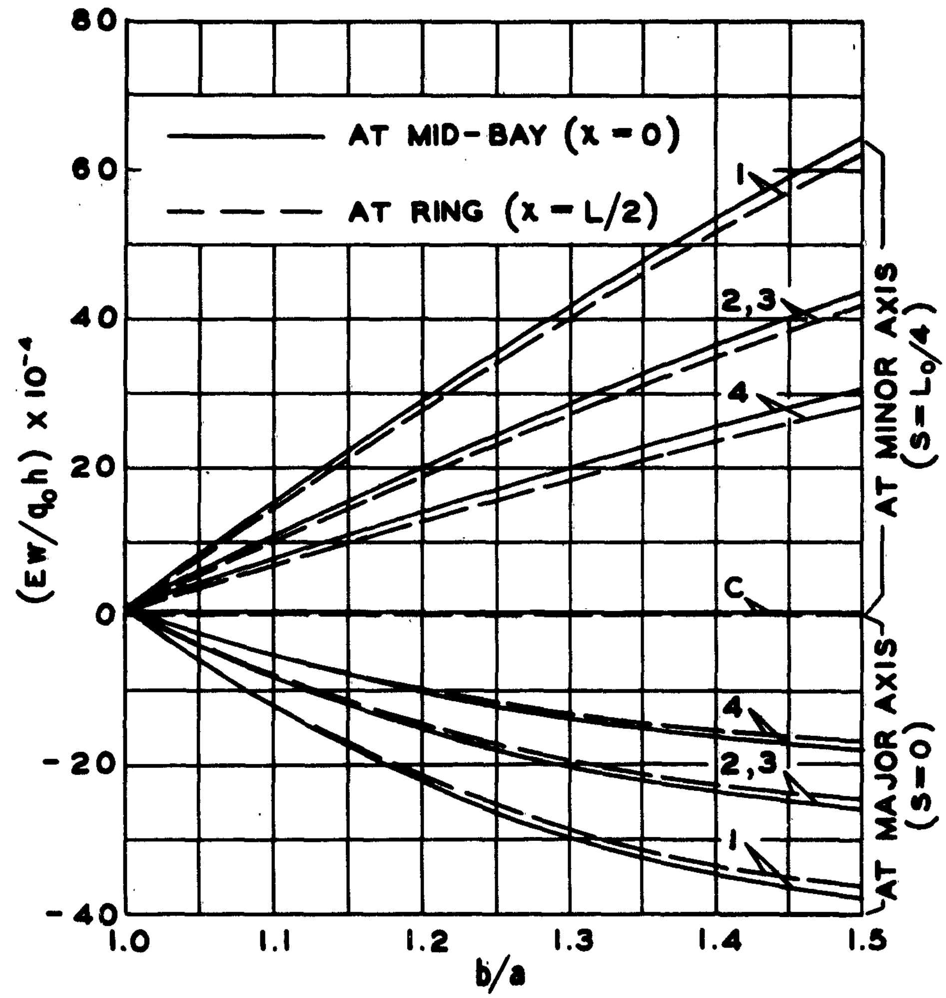

FIG. 22 RADIAL DEFORMATIONS VS b/a FOR OUTSIDE RING CASES

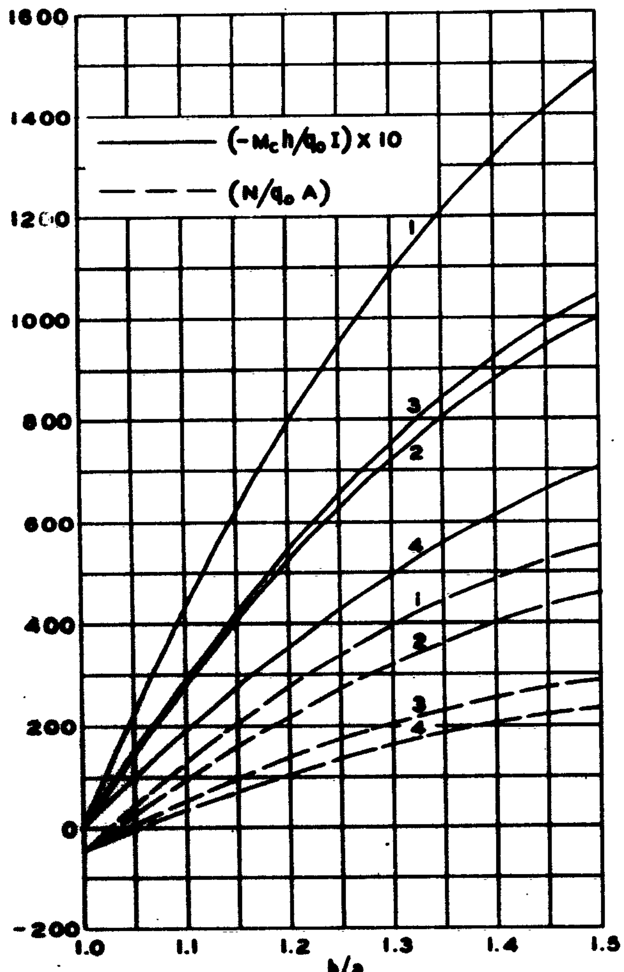

FIG. 23
CIRCUMFERENTIAL FORCE AND BENDING MOMENT IN OUTSIDE RINGS AT MAJOR AXIS (S=0)

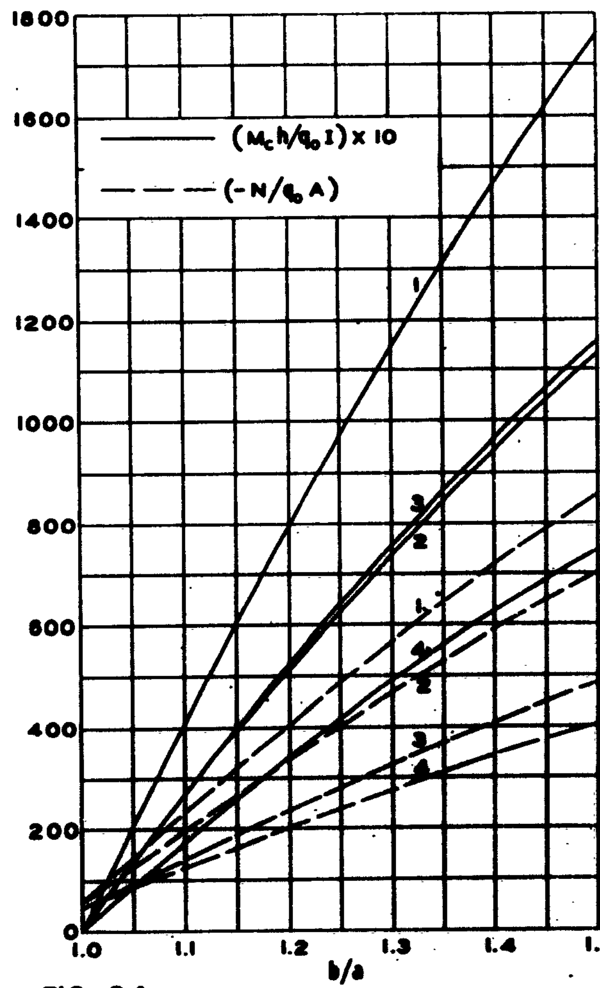

FIG. 24
CIRCUMFERENTIAL FORCE AND BENDING MOMENT IN OUTSIDE RINGS AT MINOR AXIS ($S=L_o/4$)

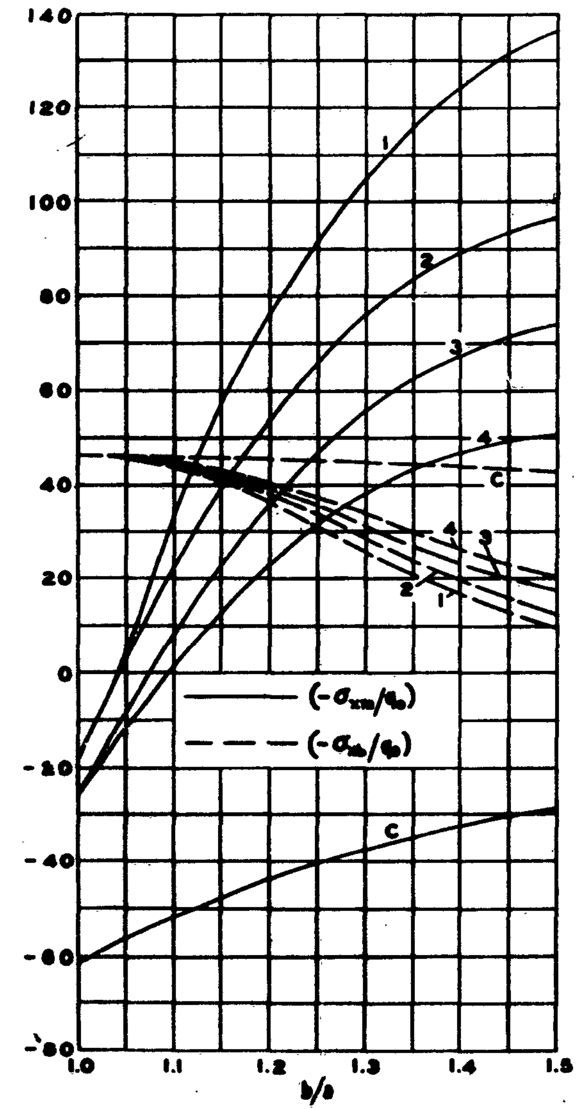

FIG. 25 AXIAL STRESS IN SHELL VS b/a AT MID-BAY, MAJOR AXIS ($x = s = 0$) FOR MEDIAN LINE RING CASES

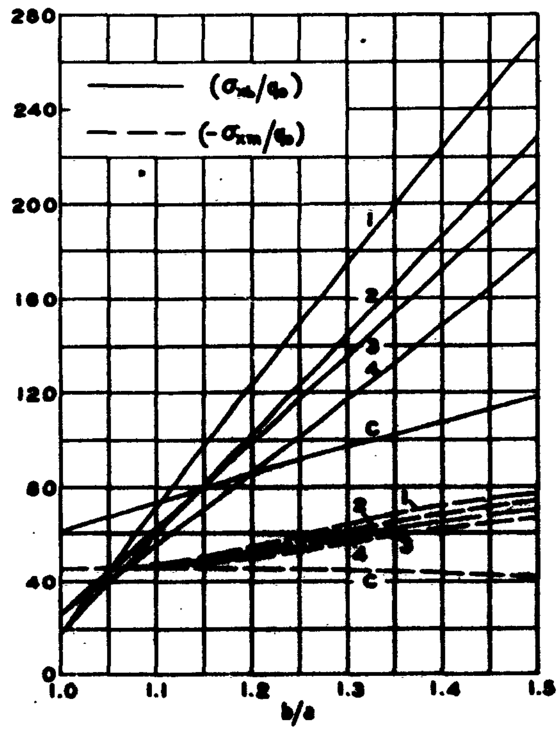

FIG. 26 AXIAL STRESS IN SHELL VS b/a AT MID-BAY, MINOR AXIS ($x = 0$, $s = L_0/4$) FOR MEDIAN LINE RING CASES

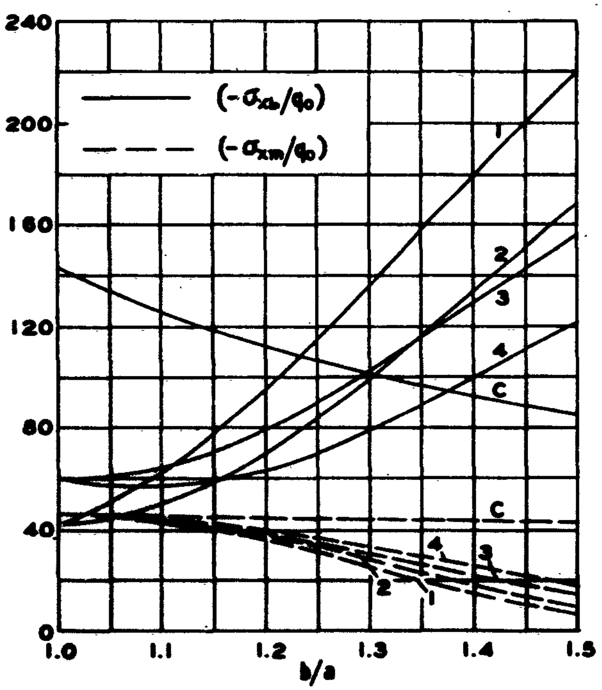

FIG. 27 AXIAL STRESS IN SHELL VS b/a AT RING, MAJOR AXIS ($x = L/2$, $s = 0$) FOR MEDIAN LINE RING CASES

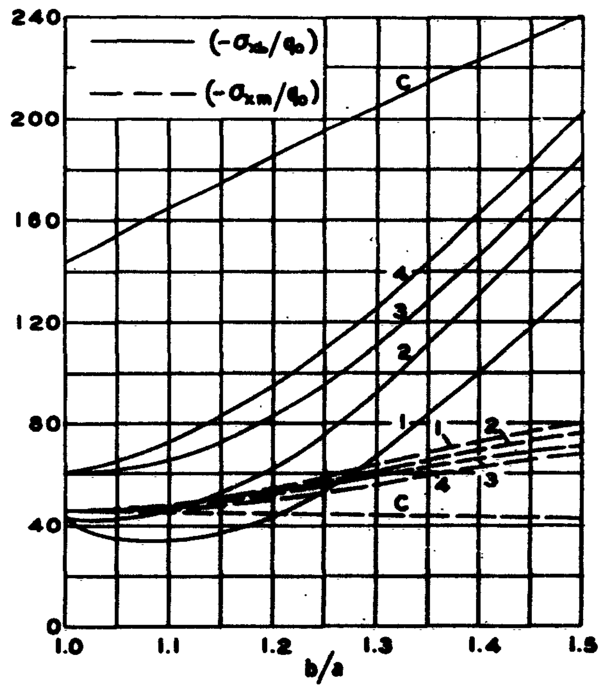

FIG. 28 AXIAL STRESS IN SHELL VS b/a AT RING, MINOR AXIS ($x = L/2$, $s = L_0/4$) FOR MEDIAN LINE RING CASES

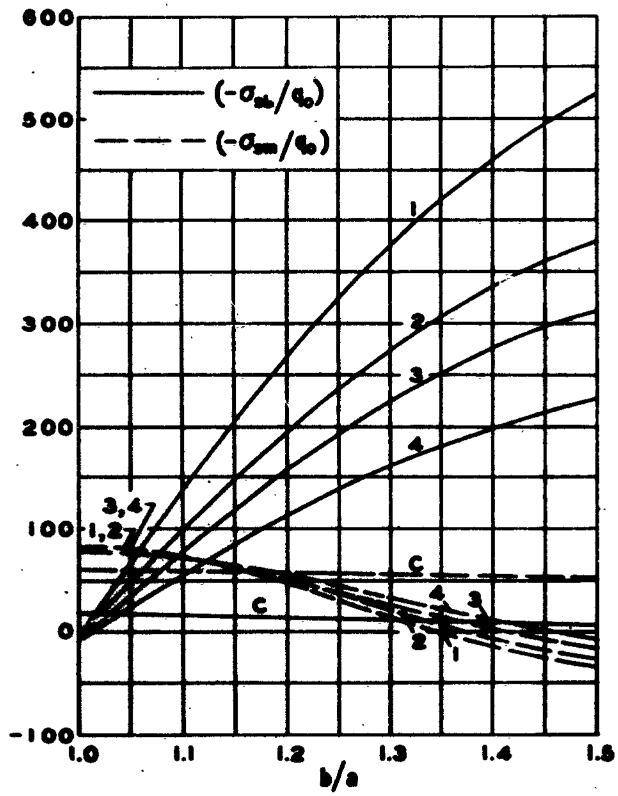

FIG. 29 CIRCUMFERENTIAL STRESS IN SHELL VS b/a AT MID-BAY, MAJOR AXIS ($\chi = s = 0$) FOR MEDIAN LINE RING CASES

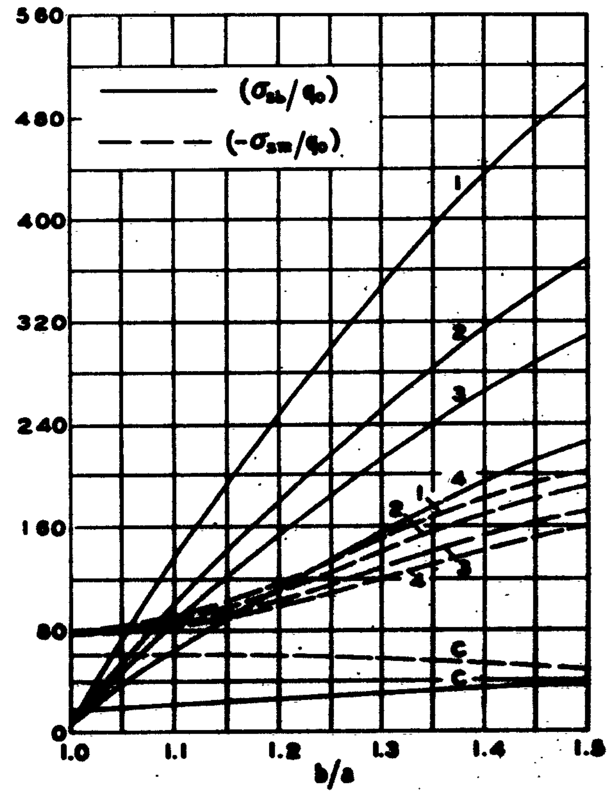

FIG. 30 CIRCUMFERENTIAL STRESS IN SHELL VS b/a AT MID-BAY, MINOR AXIS ($\chi = 0$, $s = L_0/4$) FOR MEDIAN LINE RING CASES

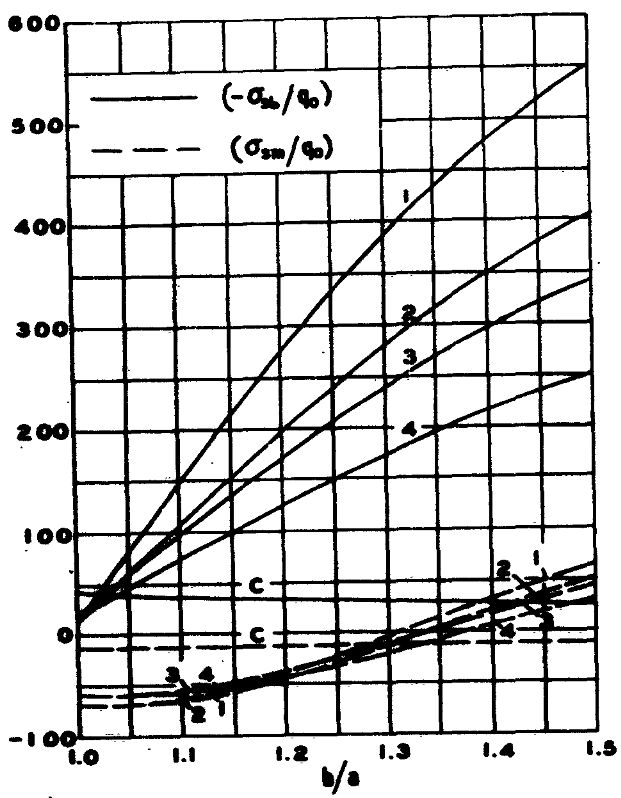

FIG. 31 CIRCUMFERENTIAL STRESS IN SHELL VS b/a AT RING, MAJOR AXIS ($x = L/2$, $s = 0$) FOR MEDIAN LINE RING CASES

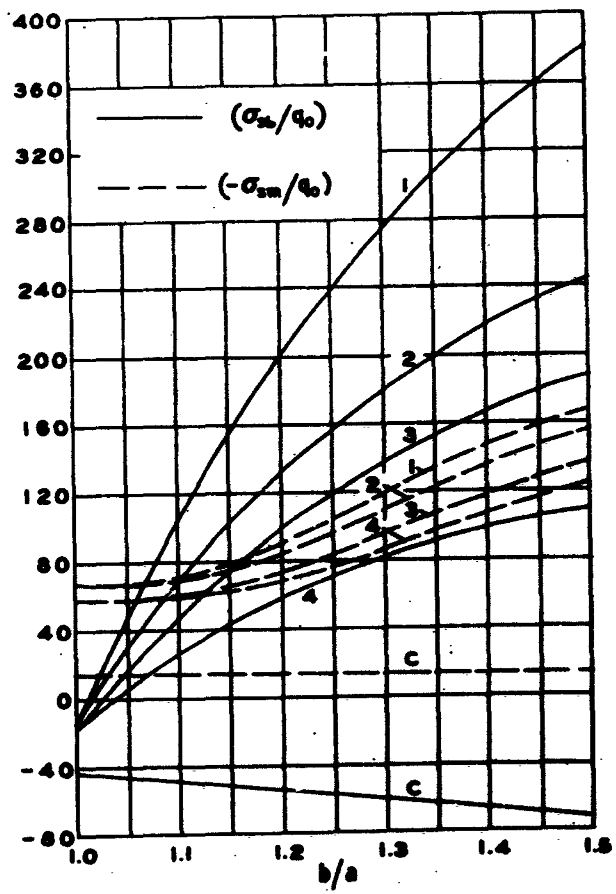

FIG. 32 CIRCUMFERENTIAL STRESS IN SHELL VS b/a AT RING, MINOR AXIS ($x = L/2$, $s = L_o/4$) FOR MEDIAN LINE RING CASES

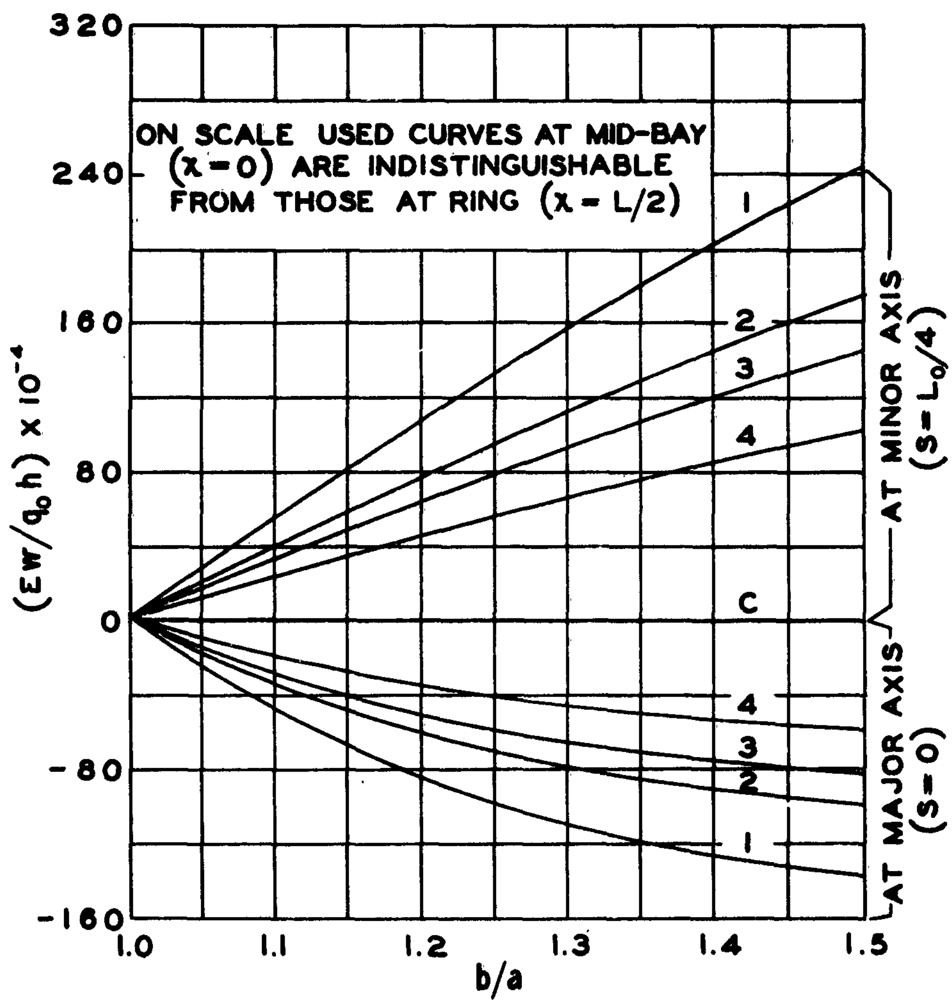

FIG. 33 RADIAL DEFORMATIONS VS b/a
FOR MEDIAN LINE RING CASES

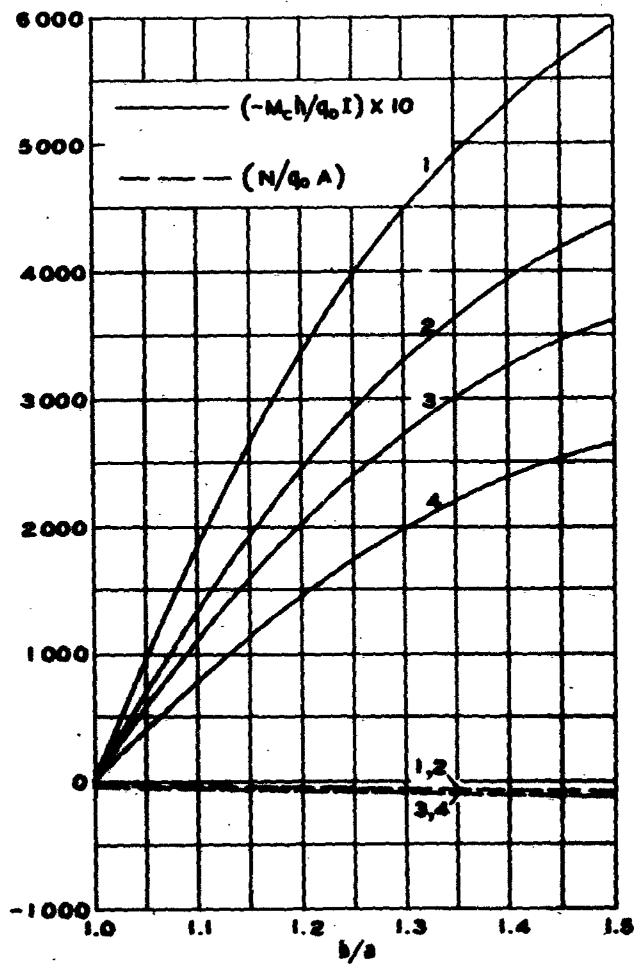

FIG. 34
CIRCUMFERENTIAL FORCE AND BENDING MOMENT IN MEDIAN LINE RINGS AT MAJOR AXIS $(S=0)$

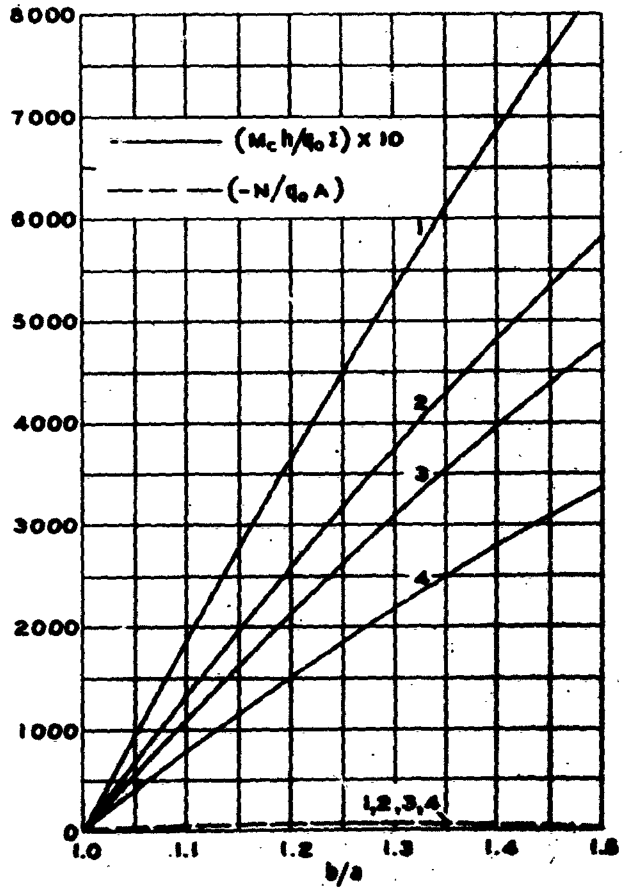

FIG. 35
CIRCUMFERENTIAL FORCE AND BENDING MOMENT IN MEDIAN LINE RINGS AT MINOR AXIS $(S=L_o/4)$

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An analysis is presented for the classical, linear, elastic behavior of a ring-reinforced oval cylinder subjected to a uniform hydrostatic pressure. Use is made of the theorem of the minimum of the total potential energy as well as an appropriate combination of the results of two previously published analyses. One of these deals with oval cylindrical shells alone, whereas the second deals with isolated oval rings. The combined analysis presented herein is employed to obtain numerical results for a limited parametric study which covers major-to-minor axis ratios in the range from 1.0 (circular cylinders) to 1.5. In addition to the anticipated result that the severity of the stresses and deformations generally increases as the major-to-minor axis ratio increases, it is shown that a change from inside rings to outside rings, or vice versa, (all other parameters being held constant) generally results in radical changes in the stress distribution throughout the entire oval cylinder.

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